A

NEW SET

OF

Logarithmic Solar Tables,

Calculated and conſtructed for determining the

LATITUDE at SEA,

BY TAKING

Two Altitudes of the Sun, with the intermediate Time, by a common Watch ; and that with Eaſe and Accuracy, independent of the Sun's meridional Altitude.

This moſt excellent and uſeful Performance, not only produces the true Latitude at any Time between Nine o'Clock in the Morning, and Three in the Afternoon ; but alſo gives the true Time of the Day, when the greateſt Altitude was taken, to twenty Seconds ; and if greater Accuracy is required, proportional Parts may be taken. Whence the Sun's Azimuth may be determined by one ſingle Proportion.

TO WHICH IS ADDED,

A COMPLETE THEORY,

Illuſtrating the RATIONALE of this moſt uſeful Diſcovery.

The SIXTH EDITION, with the TABLES enlarged.

The PROPRIETORS to the PUBLIC.

THESE Tables were offered to us by Mr. *Richard Harrison*, whose Name is subscribed to the Preface following, who assures us, in the strictest manner, that he obtained them in Manuscript from a *Hollander*, and that they have never been published : We therefore, being desirous to promote and encourage whatever has a Tendency to improve the Practice of Navigation, have purchased them of him, and hope they will prove acceptable to the Public, by answering the Purposes intended.

To the Honourable the

Admirals, Commodores, and Captains in the ROYAL NAVY, and the Worthy Commanders of Ships in the MERCHANTS SERVICE.

SIRS,

AS Trade and Navigation are the grand Source of Riches and Power, fo is the Royal Navy the Protection of Commerce, and the Prefervation (under Providence) of the Liberties, Rights, and Privileges of the *Britifh* Nation, againft the Attempts of its inviduous Enemies: Every real Improvement therefore in Navigation, juftly merits the Attention of the Public, particularly of thofe who are more immediately concerned in the fame; that this ufeful Difcovery will be found, by general Practice, to have a juft Claim hereunto, and that in an eminent Degree, I am fully affured by my own Experience; I fhall not therefore in this Preface make any further Comment upon its Utility, but only take Notice of a few Particulars antecedent, and then proceed to exhibit fuch plain, eafy Inftructions and Directions in the Application and Ufe, as that the fame may (by once carefully reading over) become intelligible and familiar, even to fuch who are only acquainted with the common Rudiments of Navigation.

This late Improvement is in no wife confined to any particular Inftrument for taking the Sun's Altitude, although the beft for that Purpofe are certainly to be preferred: I have alfo added a Table of Allowance for Heights above the Surface of the Water, and another of Refraction, which laft, at fome particular Times is more effentially to be confidered and allowed, as hereafter I have noticed.

It is not intended that this fhould, or ought to deftroy the ufual Method of finding the Latitude by meridional Obfervations; it will certainly be right to take thefe as often as they can be taken, if it is only for the Satisfaction of comparing the Agreement; but it frequently

happens

happens that this cannot be obtained, by Reason of foggy Weather, a Squall, or the Interposition of a Cloud, especially when near the Land; and after a long Voyage, for Want of the true Latitude, it too often proves fatal; whereas if the true Latitude was known, a true Course could be shaped accordingly, (proper Allowances for Variation being made, and if Observations of the Variation cannot be had, there is an accurate Chart for that Purpose lately constructed by Mr. *William Mountaine*, F.R.S. and sold by Messrs. *Mounts* and *Pages*, on *Tower-Hill*) and a good Landfall made, or the great Dangers of a narrow Channel avoided.

This new Invention has had a thorough Inspection and Trial on Board some of his Majesty's Ships of War, and has been approved as the most exact and accurate Method that ever appeared for this Purpose, and by those to whom it was communicated for Trial, kept as a great Secret; yet notwithstanding this Secrecy, it has been delivered from one Friend to another for further Experiment, who greatly avail themselves of this Curiosity and Performance, and endeavour to distinguish themselves thereby, on which Account I think it ought not to be concealed any longer, but that the same deserves, and ought to be published for general Service.

I do then hereby declare, that although I have published this Matter, yet I am not the first Inventor of these Tables, but have so much Experience in regard to the practical Part and Improvements in them, that I can sufficiently testify the Truth thereof in real Practice.

The Determination of Longitude at Sea has been long attempted, but never yet rendered practicable, (that I know of) yet it is well known, that if such a Thing as an Automaton could be constructed, that would keep true equal Time (for which Mr. *Harrison* bids the fairest) it would be of great Utility in this Respect; yet then, this would not avail, unless the true Time of the Day could be had, but the true Time of the Day cannot always be obtained, even by a meridional Observation, for it is well known to those of Experience, that

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the apparent Velocity of the Sun, or the Alteration in his Altitude, (especially in Latitudes approaching his Zenith) is so small, that he appears almost stationary for some Time, whence the true Time of his passing the Meridian cannot be exactly or accurately adjusted by this Means.

And as a small Error in Time makes a considerable Error in Longitude, that is, as 15 Degrees of Longitude is to one Hour, or as one Minute of Time to 15 Miles of Longitude, it may happen to be of a very bad Consequence, if the true Time of Noon be not duly adjusted.

But if the true Time of the Day can be exactly found, then by such Machine the Longitude of the Place is precisely fixed : Hence arises the further very great Advantage of these Tables, as, besides the Latitude, they determine the exact and true Time of the Day when the greatest Altitude is taken, by pursuing the following Directions, and which I here recommend for the public Good and Safety of Navigation ; which are the hearty Wishes of,

SIRS,

Your most obedient, and

Very humble Servant,

RICHARD HARRISON,

Of *Whitehaven.*

C

INSTRUCTIONS to the READER.

IT is to be obferved in the firft Place, that natural Sines are made Ufe of in the Performance of this Work; and as every one has not Tables hereof, I fhall fhew the Practitioner how to find them by the common Tables of Logarithms and Artificial Sines, exact to four Places of Figures, which will anfwer the End for Computation of the Latitude to one Minute, or two, and regulating the Time to 20 Seconds; but for greater Accuracy I would recommend *Sherwin's* Tables, which are exceedingly ufeful to the Aftronomer and Navigator, and contain the Natural Sines, &c.

How to find the Natural Sines.

Firft, Enter the Tables of Artificial Sines, with the Degrees and Minutes given; take thofe Figures anfwering thereto, only fubftituting 3, unlefs the Degree and Minute given be lefs than 5° 45', when fubftitute 2 for the Index; and therewith enter the Tables of Logarithms, and find the faid Figures, or the neareft thereunto, the correfponding Number is the Natural Sine of the Degree and Minutes given: For further Illuftration take an Example.

EXAMPLE.

Let it be required to find the Natural Sine of 54d. 7m.

The Artificial or Logarithmic Sine of 54d. 7m. is ——— 9.908599
Enter the Table of Logarithmic with the faid Figures, only retaining 3 for the Index, and the neareft Log. is 3.908592, whofe correfponding Number is 8102, the Natural Sine required exact to four Places.

Secondly, To find the Degrees and Minutes anfwering to any given Natural Sine.

This is done by reverfing the former Rule.

EXAMPLE.

Let 8171 be the Natural Sine given, to find the corresponding Degrees and Minutes.

The Logarithm of 8171 you will find to be 3.912275; substitute 9 for the Index, instead of 3, and find the said Number, or the nearest thereto, in the Artificial Sines, which is 9.912299, whose corresponding Degrees and Minutes are 54d. 48m. If the Number of Places of Figures of the Natural Sines was only 2, the Index must be taken 8.

Thirdly, It may be necessary to explain what is meant by the Term *Arithmetical Complement*, an *Expression* used in the following Work.

Find the Artificial Sine of the Degrees and Minutes given, and subtract each Figure (beginning on the left Hand) from 9, except the last, which take from 10; the Remainder is the *Arithmetical Complement*, and is equivalent to subtracting the Whole from 10,000, &c.

EXAMPLE

What is the Arithmetical Complement of 46° 50′?

Enter the Table of Sines with 46° 50′, gives 9.862946, each Figure taken from 9, &c. as above directed, leaves 0.137054, equivalent to 10.000000 less 9.862946.

Fourthly, To find the Logarithm Ratio.

It is to be observed, that in the following Operations, a supposed Latitude must be one of the Terms or Things given, in order to find the true Latitude and Time of the Day: This supposed Latitude must be your Latitude by Account when you take the Sun's Altitudes; but yet it does not require such an exact Computation, as to cast up the Logboard; an Estimation made by inspecting the Courses and Distances from last Noon will be sufficient, since an Error of 15 or 20 Minutes will in no wise affect the Latitude found by this new Invention, worthy of Notice; for if you designedly make an Error of one, two, or three Degrees, and repeat the Work two or three Times, still making use of the Latitude last found, for your supposed Latitude in the next Operation, it will at last discover itself to be the true, by being equal to the last

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Suppofitión, which evidently fhews the Excelleney of thefe *New Solar Tables*, preferable to any Methods heretofore made ufe of for thefe Purpofes ; but to proceed to the Logarithm Ratio.

To the Arithmetical Complement of the Co-fine of the fuppofed Latitude, add the Arithmetical Complement of the Co-fine of the Declination, the Sum gives the Logarithm Ratio.

EXAMPLE.

The fuppofed Lat. 46° 50′	Co-fine	9.835134	Arith. Com.	0.16486
Sun's Declination 11° 17′	Co-fine	9.991523		0.00847
The Logarithm Ratio ————————————————————				0.17333

Or, which is the fame Thing, and more facile ; to the Secant of the Latitude, add the Secant of the Declination, the Sum, abating twice Radius, will be the Logarithm Ratio, as above.

Fifthly, Due Regard muft be had to the Times when the Sun's Altitudes were taken, and if both the Altitudes were taken in the Forenoon, they muft be fubtracted from each other, and half that Difference is called *half the Difference of elapfed Time*; but if one Altitude be taken in the Forenoon, and the other in the Afternoon, to the Time in the Afternoon add 12h. and then fubtract, gives the intermediate Time, as before; and as in this laft Cafe, fome Difference of Longitude may be made between the Obfervations, you muft allow one Minute of Time for every 15 Miles of Longitude, and fubtract this Allowance from the Time elapfed between the Obfervations, if failing to the Weftward, but add, if failing to the Eaftward.

EXAMPLES in each CASE.

Firft, Both Altitudes in the Forenoon.

The Firft at———————————————————	10h.	2m.
The fecond at ———————————————	11h.	27m.
Subtract is the elapfed Time———————	1h.	25m.
Half the elapfed Time ———————————	0h.	42m. 30 fec.

Secondly, Sailing Westerly.

The first Altitude, Forenoon ——————10h. 26m.
The second Alt. Afternoon 2h. 43m.——————14h. 43m.

Subtract ——————————————— 4h. 17m.
Diff. Lon. made is 30m. W. equal to —— oh. 2m.
Subtract is the elapsed Time ——————— 4h. 15m.
Half the elapsed Time ——————————— 2h. 7m. 30 sec.

Thirdly, Sailing Easterly.

The first Altitude, Forenoon ——————10h. 30m.
The second Alt. Afternoon 2h. 36m.——————14h. 36m.

Subtract ——————————————— 4h. 6m.
Diff. Long. made is 15m. E. or equal to —— oh. 1m.
Add, gives the elapsed Time——————— 4h. 7m.
Half the elapsed Time ——————————— 2h. 3m. 30 sec.

Lastly, The two Observations must be taken within three Hours of Noon, but the nearer to Noon the better, provided there is a proper Interval of Time between them, as follows. Both Observations in the Forenoon; the Interval must not be much less than half the Time of the first Observation from Noon. Both after Noon; the Interval must not be much less than the Time of the first Observation from Noon; one Observation before Noon, and the other after, the Interval must not exceed five Hours.

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A TABLE

A TABLE *shewing the Depression or Dip of the visible Horizon, below the true Horizontal Plane; according to several Heights (therein mentioned) of the Observer's Eye above the Surface of the Sea; to be subtracted from the Altitude found by the Instrument, and added to the Zenith Distance.*

The Eye above the Surface of the Sea *in Feet*.	Visible Horizon depress'd in *Minutes*.
1	1
3	2
7	3
12	3
18	4
27	5
35	6
40	6
45	6
50	7

A CORRECT Table of Refraction to be subtracted from the Altitude, or added to the Zenith Distance, found by the Instrument.

Deg. App. Alt.	Refraction.		Deg. App. Alt.	Refraction.		Deg. App. Alt.	Refraction.		Deg. App. Alt.	Refraction.	
deg.	m.	f.	deg.	m.	f.	deg.	m.	f.	deg.	m.	f.
0	33	0	12	4	23	29	1	42	46	0	55
$\frac{1}{2}$	28	22	13	4	3	30	1	38	47	0	53
1	24	29	14	3	45	31	1	35	48	0	51
$1\frac{1}{2}$	21	15	15	3	30	32	1	31	49	0	49
2	18	35	16	3	17	33	1	28	50	0	48
$2\frac{1}{2}$	16	24	17	3	4	34	1	24	51	0	46
3	14	36	18	2	54	35	1	21	52	0	44
$3\frac{1}{2}$	13	34	19	2	44	36	1	18	53	0	43
4	11	51	20	2	35	37	1	16	54	0	41
$4\frac{1}{2}$	10	48	21	2	27	38	1	13	55	0	40
5	9	54	22	2	20	39	1	10	60	0	33
6	8	28	23	2	14	40	1	8	65	0	26
7	7	20	24	2	7	41	1	5	70	0	21
8	6	29	25	2	2	42	1	3	75	0	15
9	5	48	26	1	56	43	1	1	80	0	10
10	5	15	27	1	51	44	0	59	85	0	5
11	4	47	28	1	47	45	0	57	90	0	0

The Application of the foregoing Instructions to Practice.
GENERAL RULE.

First, TO the Arithmetical Complement of the Co-fine of the Latitude by Account, add the Arithmetical Complement of the Co-fine of the Sun's Declination, that Sum is the Logarithm of the Ratio.

Secondly, Subtract the Hours and Minutes of Time when the Altitudes were taken from each other, and half the Remainder is called the *Half Difference of elapfed Time.*

Thirdly, Take the Natural Sine of each Altitude; fubtract the lefs from the greater, that Difference call the *Remainder.*

Fourthly, Take the *Logarithm Ratio,* and the common Logarithm of the *Remainder ;* alfo the Logarithm of *Half the elapfed Time* anfwerable to the Hours, Minutes, and Seconds in the following Tables; thefe three added into one Sum, give the *Logarithm of the middle Time.*

Fifthly, The Hours, Minutes and Seconds anfwering to this *Logarithm of Middle Time* being found in thefe Tables, fubtract the fame from the *half elapfed Time,* or *vice verfa,* the half elapfed Time from the middle Time, the Remainder is the Time in Hours, Minutes, and Seconds, that the Sun had to afcend to the Meridian when the greateft Altitude was taken; then enter thefe Tables with this, under the Title of *Rifing,* and from the Logarithm thereto correfponding, fubtract the *Logarithm of the Ratio,* the Remainder is a common Logarithm, with which enter the common Table of Logarithms, and find the natural Number anfwering thereunto, due Regard being had to the Index.

Sixthly, To the Natural Sine of the Sun's greateft Altitude taken, add the Natural Number laft found, their Sum is the Natural Sine of the Degree and Minute of the Sun's Meridional Altitude that Day, which are eafily difcovered by obferving the fecond Rule in the former Directions concerning Natural Sines, if a Table of Natural Sines are not at Hand : And having obtained the Meridional Altitude, the Latitude is found by the ufual Rules.

Laftly, Take the Hours, Minutes, and Seconds of the *Middle Time,* and alfo of *Half the elapfed Time,* fubtract the lefs from the greater; this Dif-

ference is the true Time from Twelve o'Clock, or the Sun's paſſing over the Meridian, when the greateſt Altitude was taken; compare this with the apparent Time by the Watch or Glaſs, and if they agree, your Watch goes true, if not, the Difference ſhews how much too faſt or too ſlow.

N.B. Theſe Tables are adapted to a Table of natural Sines where the Number of Places is 5 when greateſt, the Radius being 100000. Therefore if a Table be uſed where the Number of Places is more, or the Radius greater than 100000, as many Figures muſt be left out to the right Hand as that Exceſs amounts to. Or in other Words; take the 5 firſt Places of Figures out of the Tables of Natural Sines, unleſs the Degree and Minute given be under 5° 45' when take only 4 Places of Figures: And if the Sum found according to Precept 6th conſiſts only of 4 Places of Figures, the Sun's Meridional Altitude is under 5° 45'.

For further Illuſtration, the following Examples are exhibited and performed at large.

EXAMPLE I.

AUGUST the 2d, 1772, Sun's Declination 11d. 17m. North, and at 10h. 2m. in the Forenoon, the Sun's Altitude was 46d. 55m. then again at 11h. 27m. the ſecond Altitude was 54d. 7m. Latitude by Account is 46d. 50m. North, required the true Latitude and true Time of the Day, when the greateſt Altitude was taken?

h. m. ſ.

At—11 27 0 | Lat. by Account, Arith. Comp. of its Co-ſine—0.16486
At—10 2 0 | Sun's Declination, Arith. Comp. of its Co-ſine—0.00847
Elap. 1 25 0 Added, gives the Logarithm Ratio——— 0.17333
0 42 30 Half the elapſed Time

The Sun's greateſt Alt. at 11h. 27m. is 54d. 7m. Natural Sine — 81020
The Sun's Alt. taken at 10h. 2m. is 46d. 55m. Natural Sine — 73030
Subtract————————the Remainder 7990
The Logarithm Ratio ———————— 0.17333
Common Logarithm of the Remainder ——— 3.90255
Logarithm of half elapſed Time 42m. 30 ſec. ——— 0.73429
The Sum is the Logarithm of middle Time ——— 4.81017

	h. m. ſ.
The Hour and Min. &c. for which by these Tables is	1 15 30
Subtract from it half elapsed Time	0 42 30
Their Diff. is the true Space of Time the Sun had to rise to the Meridian, when the great Altitude was taken	0 33 0

By the Watch at——11h. 27m.
Subtract it from——12h. 0m.
Remains————0h. 33m.

So I find they agree, and the Watch must be exactly right.

	Log. of Rising
Lastly, Enter these Tables with 33m. under Rising	3.01488
Ratio subtract from it	0.17333
Remains a common Logarithm, whose Natural Number must be found	2.84155
To the Natural Sine of the greatest Altitude	81020
Add the Natural Number of the above Logarithm	694
Sum is the Natural Sine of the Sun's Meridian Altitude	81714

	d. m.
The Degrees, &c. corresponding are	54 48
Subtract from	90 0
The Sun's Zenith Distance	35 12 S
Sun's Declination add	11 17 N
Latitude at Noon	46 29 N

That Day at Noon it was by Observation found to be 46d. 30m. North.

EXAMPLE II.

The Sun's Declination and Latitude as before, but at 10h. 26m. in the Forenoon, the First Altitude was 49d. 13m. the second Altitude in the Afternoon 41d. 13m. at 43 Minutes past two, at this Time had made 30m. Difference of Longitude, sailing to the Westward, I demand the Latitude when the greatest Altitude was taken, and Hour of Day?

Supposed Lat. 46d. 50m. N. Arithmetical Comp. of its Co-sine	0.16486
Sun's Decli. 11d. 17m. N. Arithmetical Comp. of its Co-sine	0.00847
The Logarithm Ratio	0.17333
Forenoon Altitude 49d. 13m. its Natural Sine	75720
Afternoon Altitude 41d. 13m. its Natural Sine	65890
The Remainder	9830

D

h. m. ſ.

h. m. f.

		Logarithm Ratio —————— 0.17333
Afternoon ———— 14 43 0		
Forenoon ————— 10 26 0		Common Logarithm Remainder 3.99255
		Logarithm of half elapfed Time 0.27731
4 17 0		
For 30 Miles — }		Logarithm of Middle Time ——— 4.44319
Diff. Longit — } 0 2 0		Equal to 0h. 32m. 0f. as by thefe Tables
4 15 0		
½ elapfed Time — 2 7 30		
Subtract ———— 0 32 0		The Sun's Dift. when greateft Al. was taken

Remains ———— 1 35 30	
Time by the }	Logarithm of 1h. 35m. 30f. called } 3.93232
Watch from } — 1 34 0	Rifing ——————————— }
12 Hours. }	Ratio from it fubtract ———— 0.17333
Remains ———— 0 1 30	A common Logarithm ———— 3.75899
Watch too faft — 1½ m.	

Whofe Natural Number is 5741 — add to greateft Alt. Natural Sine 75720

5741

Their Sum is the Natural Sine of the Sun's Meri. Alt. 54° 33′ — 81461

Or the Artificial Sine of 81461 gives ——— 54d. 33m.

From ————————————————— 90d. 0m.

Sun's Zenith Diftance ————————— 35d. 27 S.

Sun's Declination ——————————— 11d. 17 N.

Latitude at Noon ——————————— 46d. 44 N.

E X A M P L E III.

Sailing to the Eaftward, the Sun's Declination 3d. 38m. N. the firft Altitude Forenoon 46d. 2m. the fecond Altitude Afternoon 35d. 43m. Difference of Longitude made is 15 Miles E. the greater Altitude at 10h. 30m. the lefs at 36m. paft two in the Afternoon; Latitude by Account 43d. 30m. required the true Time of the Day, and Latitude of the Place at the greateft Altitude.

Lat. by Account—43d. 30m. N. Arith. Comp. of its Co-sine 0.13943
Sun's Declination— 3d. 38m. N. Arith. Comp. of its Co-sine 0.00087
The Logarithm Ratio——————————————— 0.14030

Forenoon Altitude 46d. 2m. Natural Sine ——————— 71970
Afternoon Altitude 35d. 43m. Natural Sine ————— 58370
The Remainder—————————————————— 13600

	h.	m.	s.		
Afternoon ————	14	36	0	Logarithm Ratio ————	0.14030
Forenoon ———	10	30	0	Common Logarithm Remainder	4.13353
		4 6 0		Half elapsed Time ———	0.28974
Diff. Longit. 15 } Miles add 1 min. }	0	1	0	Logarithm of Middle Time——	4.56357
		4 7 0		Equal to ——— 0h. 42m. 0s.	
½ elapsed Time——	2	3	30	Logarithm of 1h. 21m. 30s. rising	3.79634
Subtract ————	0	42	0	Ratio from it————	0.14030
True Time ——	1	21	30	Common Logarithm————	3.65604
Sun had to rise by } the Watch }	1	30	0		
Difference————	0	8	30		
Watch too slow 8½ Minutes.					

The Natural Sine of the greatest Altitude ——————— 71970
The Natural Number of the Common Logarithm 3.65604 is — 4529
Their Sum ———————————————————— 76499

The Artificial Sine of 76499, or Natural Sine 7650 —49d. 54m.
From ———————————————————— 90d. 0m.
Sun's Zenith Distance ——————————— 4d. 6m. S.
Sun's Declination add ——————————— 3d. 38m. N.
Latitude at Noon ——————————— 43d. 44m. N.

Having thus found the true Latitude to be 43d. 44m and the Time by the Watch corrected 10h. 38m. 30s. when the Sun's Morning Altitude was taken, we may find the true Time from Noon thus :

Comp.

	d. m.		
Comp. Lat.	46 16	Comp. Lat. Co. Ar.	0.141123
Comp. Alt.	43 58	Comp. Dec. Co. Ar.	0.000874
Comp. Declin.	86 22	Sine of half Sum	0.999809
Sum	176 36	Sine of the Remainder	9.844372
½ Sum from which } sub. Co. Alt. }	88 18	Sum	19.986178
		Half Sum	9.993089
Remainder	44 20		

	d. m.
Equal to	79 48
Doubled	159 36
Subtract from	180 00
Remains	20 24

Equal to 1h. 21m. 36f. from Noon nearly.

The Time from Noon by the Work in the laft Example appears to be 1h. 21m. 30f. differing only fix Seconds.

By help of thefe Operations the true Azimuth is eafily determined, having oppofite Sides and Angles given; and as a tolerable Watch cannot be fuppofed to vary in the Space of one, two or three Hours, the fame being duly rectified and adjufted, as before laid down, the Azimuth may be taken at any reafonable Time afterwards, and the Variation of the Compafs afcertained in a very eafy and familiar Manner, as in the following

E X A M P L E.

In the Latitude of 51d. 30m. North, the Sun's Declination 15d. 10m. North, at two Minutes paft fix in the Afternoon, the Sun's Altitude was 11d. 30m. the Sun's true Azimuth is required at that Time?

The P R O P O R T I O N.

As the Co-fine of the Sun's Altitude	78d. 30m.	9.991193
Is to the Sine of the Hour from Noon	6h. 2m.=90 30	9.999983
So is the Co-fine of the Sun's Declination	74 50	9.084603
		19.084580
To the Sine of the Sun's Azimuth	=80 2	9.993393

Or its Supplement to 180° from the elevated Pole.

The

H	M	S	½ Elapsed Time.	Middle Time.	Rising.	H	M	S	½ Elapsed Time.	Middle Time.	Rising
0	0	20	2.83730	2.46373	$\bar{1}$.02436	0	12	20	1.26931	4.03172	2.16066
0	0	30	2.66121	2.63982	$\bar{1}$.37654	0	12	30	1.26349	4.03754	2.17223
0	0	40	2.53627	2.76476	$\bar{1}$.62642	0	12	40	1.25774	4.04329	2.18382
0	1	00	2.36018	2.94085	$\bar{1}$.97860	0	13	00	1.24647	4.05456	2.20638
0	1	20	2.23525	3.06578	0.22848	0	13	20	1.23549	4.06554	2.22836
0	1	30	2.18409	3.11694	0.33079	0	13	30	1.23010	4.07093	2.23915
0	1	40	2.13834	3.16269	0.42230	0	13	40	1.22477	4.07626	2.24980
0	2	00	2.05916	3.24187	0.58066	0	14	00	1.21432	4.08671	2.27073
0	2	20	1.99221	3.30883	0.71455	0	14	20	1.20412	4.09691	2.29116
0	2	30	1.96225	3.33878	0.77448	0	14	30	1.19910	4.10193	2.30120
0	2	40	1.93422	3.36681	0.83054	0	14	40	1.19415	4.10688	2.31112
0	3	00	1.88307	3.41796	0.93284	0	15	00	1.18440	4.11663	2.33063
0	3	20	1.83732	3.46371	1.02435	0	15	20	1.17487	4.12616	2.34972
0	3	30	1.81613	3.48490	1.06673	0	15	30	1.17018	4.13085	2.35910
0	3	40	1.79593	3.50510	1.10714	0	15	40	1.16554	4.13549	2.36839
0	4	00	1.75814	3.54289	1.18271	0	16	00	1.15642	4.14461	2.38667
0	4	20	1.72339	3.57764	1.25224	0	16	20	1.14748	4.15355	2.40457
0	4	30	1.70700	3.59403	1.28502	0	16	30	1.14307	4.15796	2.41338
0	4	40	1.69121	3.60982	1.31660	0	16	40	1.13872	4.16231	2.42211
0	5	00	1.66125	3.63978	1.37653	0	17	00	1.13013	4.17090	2.43930
0	5	20	1.63322	3.66781	1.43258	0	17	20	1.12171	4.17932	2.45616
0	5	30	1.61986	3.68117	1.45931	0	17	30	1.11757	4.18346	2.46447
0	5	40	1.60690	3.69413	1.48524	0	17	40	1.11346	4.18757	2.47270
0	6	00	1.58208	3.71895	1.53488	0	18	00	1.10536	4.19567	2.48893
0	6	20	1.55861	3.74242	1.58184	0	18	20	1.09740	4.20363	2.50486
0	6	30	1.54733	3.75370	1.60440	0	18	30	1.09348	4.20755	2.51271
0	6	40	1.53634	3.76469	1.62639	0	18	40	1.08960	4.21143	2.52050
0	7	00	1.51515	3.78588	1.66877	0	19	00	1.08193	4.21910	2.53586
0	7	20	1.49496	3.80607	1.70917	0	19	20	1.07439	4.22664	2.55096
0	7	30	1.48520	3.81583	1.72869	0	19	30	1.07067	4.23036	2.55841
0	7	40	1.47566	3.82537	1.74778	0	19	40	1.06698	4.23405	2.56580
0	8	00	1.45718	3.84385	1.78474	0	20	00	1.05970	4.24133	2.58039
0	8	20	1.43946	3.86157	1.82019	0	20	20	1.05254	4.24849	2.59473
0	8	30	1.43086	3.87017	1.83739	0	20	30	1.04901	4.25202	2.60182
0	8	40	1.42243	3.87860	1.85426	0	20	40	1.04550	4.25553	2.60885
0	9	00	1.40605	3.89498	1.88703	0	21	00	1.03857	4.26246	2.62274
0	9	20	1.39027	3.91076	1.91862	0	21	20	1.03175	4.26928	2.63641
0	9	30	1.38258	3.91845	1.93399	0	21	30	1.02838	4.27265	2.64316
0	9	40	1.37503	3.92600	1.94909	0	21	40	1.02504	4.27599	2.64987
0	10	00	1.36032	3.94071	1.97854	0	22	00	1.01843	4.28260	2.66312
0	10	20	1.34609	3.95494	2.00699	0	22	20	1.01192	4.28911	2.67617
0	10	30	1.33915	3.96188	2.02091	0	22	30	1.00870	4.29233	2.68262
0	10	40	1.33231	3.96872	2.03458	0	22	40	1.00550	4.29553	2.68903
0	11	00	1.31896	3.98207	2.06131	0	23	00	0.99918	4.30185	2.70169
0	11	20	1.30600	3.99503	2.08723	0	23	20	0.99296	4.30807	2.71418
0	11	30	1.29967	4.00136	2.09991	0	23	30	0.98988	4.31115	2.72036
0	11	40	1.29342	4.00761	2.11240	0	23	40	0.98682	4.31421	2.72649
0	12	00	1.28120	4.01983	2.13867	0	24	00	0.98077	4.32026	2.73863

H	M	S	½ Elapsed Time.	Middle Time.	Rising.	H	M	S	½ Elapsed Time.	Middle Time.	Rising.
0	24	20	0.97480	4.32623	2.75060	0	36	20	0.80170	4.49933	3.09830
0	24	30	0.97184	4.32919	2.75652	0	36	30	0.79973	4.50130	3.10227
0	24	40	0.96891	4.33212	2.76241	0	36	40	0.79777	4.50326	3.10622
0	25	00	0.96310	4.33793	2.77405	0	37	00	0.79387	4.50716	3.11406
0	25	20	0.95738	4.34365	2.78555	0	37	20	0.79001	4.51102	3.12184
0	25	30	0.95454	4.34649	2.79124	0	37	30	0.78809	4.51294	3.12570
0	25	40	0.95172	4.34931	2.79689	0	37	40	0.78618	4.51485	3.12954
0	26	00	0.94614	4.35489	2.80809	0	38	00	0.78239	4.51864	3.13718
0	26	20	0.94063	4.36040	2.81914	0	38	20	0.77863	4.52240	3.14475
0	26	30	0.93790	4.36313	2.82461	0	38	30	0.77677	4.52426	3.14850
0	26	40	0.93519	4.36584	2.83005	0	38	40	0.77491	4.52612	3.15225
0	27	00	0.92982	4.37121	2.84083	0	39	00	0.77122	4.52981	3.15969
0	27	20	0.92452	4.37651	2.85148	0	39	20	0.76756	4.53347	3.16706
0	27	30	0.92189	4.37914	2.85675	0	39	30	0.76574	4.53529	3.17072
0	27	40	0.91928	4.38175	2.86199	0	39	40	0.76393	4.53710	3.17437
0	28	00	0.91411	4.38692	2.87238	0	40	00	0.76033	4.54070	3.18162
0	28	20	0.90899	4.39204	2.88265	0	40	20	0.75676	4.54427	3.18881
0	28	30	0.90646	4.39457	2.88773	0	40	30	0.75499	4.54604	3.19238
0	28	40	0.90394	4.39709	2.89279	0	40	40	0.75323	4.54780	3.19594
0	29	00	0.89894	4.40209	2.90282	0	41	00	0.74972	4.55131	3.20301
0	29	20	0.89401	4.40702	2.91273	0	41	20	0.74624	4.55479	3.21003
0	29	30	0.89156	4.40947	2.91765	0	41	30	0.74451	4.55652	3.21351
0	29	40	0.88913	4.41190	2.92254	0	41	40	0.74279	4.55824	3.21698
0	30	00	0.88430	4.41673	2.93223	0	42	00	0.73937	4.56166	3.22389
0	30	20	0.87953	4.42150	2.94181	0	42	20	0.73597	4.56506	3.23073
0	30	30	0.87717	4.42386	2.94656	0	42	30	0.73429	4.56674	3.23414
0	30	40	0.87481	4.42622	2.95129	0	42	40	0.73261	4.56842	3.23753
0	31	00	0.87015	4.43088	2.96067	0	43	00	0.72926	4.57177	3.24427
0	31	20	0.86553	4.43550	2.96994	0	43	20	0.72595	4.57508	3.25095
0	31	30	0.86324	4.43779	2.97454	0	43	30	0.72430	4.57673	3.25428
0	31	40	0.86096	4.44007	2.97912	0	43	40	0.72266	4.57837	3.25759
0	32	00	0.85644	4.44459	2.98820	0	44	00	0.71940	4.58163	3.26418
0	32	20	0.85197	4.44906	2.99718	0	44	20	0.71616	4.58487	3.27072
0	32	30	0.84976	4.45127	2.00164	0	44	30	0.71455	4.58648	3.27396
0	32	40	0.84755	4.45348	2.00608	0	44	40	0.71295	4.58108	3.27720
0	33	00	0.84317	4.45786	2.01488	0	45	00	0.70976	4.59127	3.28363
0	33	20	0.83884	4.46219	2.02360	0	45	20	0.70660	4.59443	3.29002
0	33	30	0.83669	4.46434	2.02792	0	45	30	0.70503	4.59600	3.29320
0	33	40	0.83455	4.46648	2.03222	0	45	40	0.70346	4.59751	3.29637
0	34	00	0.83030	4.47073	2.04077	0	46	00	0.70034	4.60069	3.30266
0	34	20	0.82609	4.47494	2.04922	0	46	20	0.69725	4.60378	3.30891
0	34	30	0.82401	4.47702	2.05342	0	46	30	0.69571	4.60532	3.31202
0	34	40	0.82193	4.47910	2.05760	0	46	40	0.69418	4.60685	3.31512
0	35	00	0.81780	4.48323	2.06590	0	47	00	0.69113	4.60990	3.32128
0	35	20	0.81372	4.48731	2.07411	0	47	20	0.68811	4.61292	3.32739
0	35	30	0.81169	4.48934	2.07819	0	47	30	0.68660	4.61443	3.33044
0	35	40	0.80967	4.49136	2.08225	0	47	40	0.68510	4.61593	3.33347
0	36	00	0.80567	4.49536	2.09032	0	48	00	0.68212	4.61892	3.33950

H	M	S	½ Elapsed Time.	Middle Time.	Rising.	H	M	S	½ Elapsed Time.	Middle Time.	Rising
0	48	20	0.67916	4.62187	3.34549	1	60	20	0.58465	4.71638	3.53721
0	48	30	0.67769	4.62334	3.34847	1	60	30	0.58348	4.71755	3.53959
0	48	40	0.67622	4.62481	3.35144	1	60	40	0.58231	4.71872	3.54197
0	49	00	0.67330	4.62773	3.35734	1	1	00	0.57999	4.72104	3.54670
0	49	20	0.67040	4.63063	3.36321	1	1	20	0.57768	4.72335	3.55140
0	49	30	0.66896	4.63207	3.36613	1	1	30	0.57653	4.72450	3.55375
0	49	40	0.66752	4.63351	3.36903	1	1	40	0.57538	4.72565	3.55608
0	50	00	0.66466	4.63637	3.37482	1	2	00	0.57310	4.72793	3.56074
0	50	20	0.66182	4.63921	3.38057	1	2	20	0.57083	4.73020	3.56537
0	50	30	0.66041	4.64062	3.38343	1	2	30	0.56970	4.73133	3.56767
0	50	40	0.65900	4.64203	3.38628	1	2	40	0.56857	4.73246	3.56997
0	51	00	0.65620	4.64483	3.39195	1	3	00	0.56633	4.73470	3.57455
0	51	20	0.65342	4.64761	3.39759	1	3	20	0.56409	4.73694	3.57910
0	51	30	0.65204	4.64899	3.40039	1	3	30	0.56298	4.73805	3.58137
0	51	40	0.65066	4.65037	3.40318	1	3	40	0.56187	4.73916	3.58363
0	52	00	0.64791	4.65312	3.40875	1	4	00	0.55966	4.74137	3.58814
0	52	20	0.64519	4.65584	3.41427	1	4	20	0.55746	4.74357	3.59262
0	52	30	0.64383	4.65720	3.41702	1	4	30	0.55637	4.74466	3.59486
0	52	40	0.64248	4.65855	3.41976	1	4	40	0.55528	4.74575	3.59708
0	53	00	0.63978	4.66125	3.42523	1	5	00	0.55311	4.74792	3.60152
0	53	20	0.63711	4.66392	3.43064	1	5	20	0.55095	4.75008	3.60593
0	53	30	0.63578	4.66525	3.43334	1	5	30	0.54987	4.75116	3.60813
0	53	40	0.63445	4.66658	3.43603	1	5	40	0.54880	4.75223	3.61032
0	54	00	0.63181	4.66922	3.44138	1	6	00	0.54666	4.75437	3.61469
0	54	20	0.62919	4.67184	3.44670	1	6	20	0.54453	4.75650	3.61903
0	54	30	0.62789	4.67314	3.44935	1	6	30	0.54347	4.75756	3.62120
0	54	40	0.62659	4.67444	3.45199	1	6	40	0.54241	4.75862	3.62336
0	55	00	0.62400	4.67703	3.45724	1	7	00	0.54031	4.76072	3.62766
0	55	20	0.62142	4.67961	3.46247	1	7	20	0.53822	4.76281	3.63194
0	55	30	0.62014	4.68089	3.46507	1	7	30	0.53718	4.76385	3.63407
0	55	40	0.61886	4.68217	3.46765	1	7	40	0.53614	4.76489	3.63620
0	56	00	0.61632	4.68471	3.47282	1	8	00	0.53406	4.76697	3.64043
0	56	20	0.61380	4.68723	3.47795	1	8	20	0.53200	4.76903	3.64465
0	56	30	0.61254	4.68849	3.48050	1	8	30	0.53097	4.77006	3.64675
0	56	40	0.61129	4.68974	3.48305	1	8	40	0.52995	4.77108	3.64885
0	57	00	0.60879	4.69224	3.48811	1	9	00	0.52791	4.77312	3.65302
0	57	20	0.60631	4.69472	3.49315	1	9	20	0.52589	4.77514	3.65717
0	57	30	0.60508	4.69595	3.49566	1	9	30	0.52488	4.77615	3.65924
0	57	40	0.60385	4.69718	3.49816	1	9	40	0.52387	4.77716	3.66131
0	58	00	0.60140	4.69963	3.50314	1	10	00	0.52186	4.77917	3.66542
0	58	20	0.59896	4.70207	3.50809	1	10	20	0.51986	4.78117	3.66952
0	58	30	0.59775	4.70328	3.51056	1	10	30	0.51886	4.78217	3.67156
0	58	40	0.59654	4.70449	3.51301	1	10	40	0.51787	4.78316	3.67359
0	59	00	0.59414	4.70689	3.51791	1	11	00	0.51589	4.78514	3.67756
0	59	20	0.59175	4.70928	3.52278	1	11	20	0.51392	4.78711	3.68168
0	59	30	0.59056	4.71047	3.52520	1	11	30	0.51294	4.78809	3.68369
0	59	40	0.58937	4.71166	3.52761	1	11	40	0.51196	4.78907	3.68570
1	60	00	0.58700	4.71403	3.53243	1	12	00	0.51002	4.79101	3.68969

H	M	S	½ Elapsed Time.	Middle Time.	Rising.	H	M	S	½ Elapsed Time.	Middle Time.	Rising.
1	12	20	0.50808	4.79295	3.69367	1	24	20	0.44403	4.85700	3.82570
1	12	30	0.50711	4.79392	3.69566	1	24	30	0.44321	4.85782	3.82739
1	12	40	0.50615	4.79488	3.69763	1	24	40	0.44239	4.85864	3.82908
1	13	00	0.50423	4.79680	3.70158	1	25	00	0.44077	4.86026	3.83246
1	13	20	0.50232	4.79871	3.70550	1	25	20	0.43915	4.86188	3.83582
1	13	30	0.50137	4.79966	3.70745	1	25	30	0.43834	4.86269	3.83749
1	13	40	0.50042	4.80061	3.70940	1	25	40	0.43753	4.86350	3.83917
1	14	00	0.49852	4.80251	3.71329	1	26	00	0.43593	4.86510	3.84250
1	14	20	0.49664	4.80439	3.71716	1	26	20	0.43433	4.86670	3.84582
1	14	30	0.49570	4.80533	3.71909	1	26	30	0.43353	4.86750	3.84748
1	14	40	0.49476	4.80627	3.72101	1	26	40	0.43273	4.86830	3.84913
1	15	00	0.49290	4.80813	3.72485	1	27	00	0.43114	4.86989	3.85242
1	15	20	0.49104	4.80999	3.72867	1	27	20	0.42956	4.87147	3.85570
1	15	30	0.49012	4.81091	3.73057	1	27	30	0.42877	4.87226	3.85734
1	15	40	0.48920	4.81183	3.73247	1	27	40	0.42799	4.87304	3.85897
1	16	00	0.48736	4.81367	3.73625	1	28	00	0.42643	4.87460	3.86223
1	16	20	0.48553	4.81550	3.74001	1	28	20	0.42487	4.87616	3.86547
1	16	30	0.48462	4.81641	3.74189	1	28	30	0.42409	4.87694	3.86709
1	16	40	0.48371	4.81732	3.74376	1	28	40	0.42331	4.87772	3.86870
1	17	00	0.48189	4.81914	3.74750	1	29	00	0.42176	4.87927	3.87192
1	17	20	0.48009	4.82004	3.75121	1	29	20	0.42022	4.88081	3.87513
1	17	30	0.47919	4.82184	3.75307	1	29	30	0.41945	4.88158	3.87672
1	17	40	0.47829	4.82274	3.75491	1	29	40	0.41868	4.88235	3.87832
1	18	00	0.47650	4.82453	3.75860	1	30	00	0.41716	4.88387	3.88150
1	18	20	0.47472	4.82631	3.76227	1	30	20	0.41564	4.88539	3.88467
1	18	30	0.47383	4.82720	3.76409	1	30	30	0.41488	4.88615	3.88625
1	18	40	0.47295	4.82808	3.76592	1	30	40	0.41412	4.88691	3.88783
1	19	00	0.47119	4.82984	3.76955	1	31	00	0.41261	4.88842	3.89097
1	19	20	0.46943	4.83160	3.77318	1	31	20	0.41111	4.88992	3.89411
1	19	30	0.46856	4.83247	3.77498	1	31	30	0.41036	4.89067	3.89567
1	19	40	0.46769	4.83334	3.77678	1	31	40	0.40961	4.89142	3.89723
1	20	00	0.46595	4.83508	3.78037	1	32	00	0.40812	4.89291	3.90034
1	20	20	0.46421	4.83682	3.78395	1	32	20	0.40664	4.89439	3.90344
1	20	30	0.46335	4.83768	3.78573	1	32	30	0.40590	4.89513	3.90498
1	20	40	0.46249	4.83854	3.78759	1	32	40	0.40516	4.89587	3.90653
1	21	00	0.46077	4.84026	3.79105	1	33	00	0.40368	4.89735	3.90960
1	21	20	0.45907	4.84196	3.79458	1	33	20	0.40222	4.89881	3.91267
1	21	30	0.45822	4.84281	3.79634	1	33	30	0.40149	4.89954	3.91420
1	21	40	0.45737	4.84366	3.79809	1	33	40	0.40076	4.90027	3.91572
1	22	00	0.45567	4.84536	3.80159	1	34	00	0.39930	4.90173	3.91876
1	22	20	0.45399	4.84704	3.80508	1	34	20	0.39785	4.90318	3.92179
1	22	30	0.45315	4.84788	3.80682	1	34	30	0.39713	4.90390	3.92331
1	22	40	0.45231	4.84872	3.80855	1	34	40	0.39641	4.90462	3.92482
1	23	00	0.45064	4.85039	3.81201	1	35	00	0.39497	4.90606	3.92782
1	23	20	0.44898	4.85205	3.81545	1	35	20	0.39353	4.90750	3.93082
1	23	30	0.44815	4.85288	3.81717	1	35	30	0.39282	4.90821	3.93232
1	23	40	0.44732	4.85371	3.81888	1	35	40	0.39211	4.90892	3.93381
1	24	00	0.44567	4.85536	3.82230	1	36	00	0.39069	4.91034	3.93679

H	M	S	½ Elapsed Time.	Middle Time:	Rising.	H	M	S	½ Elapsed Time.	Middle Time.	Rising
1	36	20	0.38927	4.91176	3.93975	1	48	20	0.34172	4.95931	4.04003
1	36	30	0.38856	4.91247	3.94123	1	48	30	0.34110	4.95993	4.04134
1	36	40	0.38786	4.91317	3.94271	1	48	40	0.34048	4.96055	4.04265
1	37	00	0.38646	4.91457	3.94466	1	49	00	0.33925	4.96178	4.04526
1	37	20	0.38506	4.91597	3.95859	1	49	20	0.33803	4.96300	4.04786
1	37	30	0.38436	4.91667	3.95005	1	49	30	0.33742	4.96361	4.04916
1	37	40	0.38366	4.91737	3.95151	1	49	40	0.33681	4.96422	4.05045
1	38	00	0.38227	4.91876	3.95443	1	50	00	0.33559	4.96544	4.05304
1	38	20	0.38089	4.92014	3.95733	1	50	20	0.33438	4.96665	4.05561
1	38	30	0.38020	4.92083	3.95878	1	50	30	0.33378	4.96725	4.05690
1	38	40	0.37951	4.92152	3.96023	1	50	40	0.33318	4.96785	4.05818
1	39	00	0.37813	4.92290	3.96311	1	51	00	0.33197	4.96906	4.06074
1	39	20	0.37677	4.92426	3.96599	1	51	20	0.33077	4.97026	4.06330
1	39	30	0.37609	4.92494	3.96742	1	51	30	0.33017	4.97086	4.06457
1	39	40	0.37541	4.92562	3.96885	1	51	40	0.32958	4.97145	4.06584
1	40	00	0.37405	4.92698	3.97170	1	52	00	0.32839	4.97264	4.06838
1	40	20	0.37269	4.92834	3.97455	1	52	20	0.32720	4.97383	4.07091
1	40	30	0.37202	4.92901	3.97597	1	52	30	0.32661	4.97442	4.07217
1	40	40	0.37135	4.92968	3.97738	1	52	40	0.32602	4.97501	4.07343
1	41	00	0.37001	4.93102	3.97021	1	53	00	0.32485	4.97618	4.07595
1	41	20	0.36867	4.93236	3.98302	1	53	20	0.32367	4.97736	4.07845
1	41	30	0.36800	4.93303	3.98443	1	53	30	0.32309	4.97794	4.07970
1	41	40	0.36734	4.93369	3.98583	1	53	40	0.32250	4.97853	4.08095
1	42	00	0.36602	4.93501	3.98862	1	54	00	0.32134	4.97969	4.08344
1	42	20	0.36470	4.93633	3.99141	1	54	20	0.32018	4.98085	4.08592
1	42	30	0.36404	4.93699	3.99280	1	54	30	0.31960	4.98143	4.08716
1	42	40	0.36338	4.93765	3.99419	1	54	40	0.31902	4.98201	4.08840
1	43	00	0.36206	4.93897	3.99696	1	55	00	0.31787	4.98316	4.09087
1	43	20	0.36070	4.94027	3.99972	1	55	20	0.31672	4.98431	4.09333
1	43	30	0.36011	4.94092	4.00109	1	55	30	0.31614	4.98489	4.09456
1	43	40	0.35946	4.94157	4.00247	1	55	40	0.31557	4.98546	4.09578
1	44	00	0.35816	4.94287	4.00521	1	56	00	0.31443	4.98660	4.09823
1	44	20	0.35686	4.94417	4.00793	1	56	20	0.31329	4.98774	4.10067
1	44	30	0.35622	4.94481	4.00930	1	56	30	0.31272	4.98831	4.10188
1	44	40	0.35558	4.94545	4.01006	1	56	40	0.31216	4.98887	4.10310
1	45	00	0.35430	4.94673	4.01337	1	57	00	0.31103	4.99000	4.10552
1	45	20	0.35302	4.94801	4.01608	1	57	20	0.30990	4.99113	4.10794
1	45	30	0.35238	4.94865	4.01743	1	57	30	0.30934	4.99169	4.10915
1	45	40	0.35174	4.94929	4.01877	1	57	40	0.30878	4.99225	4.11035
1	46	00	0.35047	4.95056	4.02146	1	58	00	0.30776	4.99337	4.11275
1	46	20	0.34921	4.95182	4.02414	1	58	20	0.30655	4.99448	4.11515
1	46	30	0.34858	4.95245	4.02547	1	58	30	0.30599	4.99504	4.11634
1	46	40	0.34795	4.95308	4.02681	1	58	40	0.30544	4.99559	4.11754
1	47	00	0.34669	4.95434	4.02947	1	59	00	0.30433	4.99670	4.11992
1	47	20	0.34544	4.95559	4.03212	1	59	20	0.30323	4.99780	4.12229
1	47	30	0.34482	4.95621	4.03344	1	59	30	0.30268	4.99835	4.12348
1	47	40	0.34420	4.95683	4.03477	1	59	40	0.30213	4.99890	4.12466
1	48	00	0.34296	4.95807	4.03740	2	00	00	0.30103	5.00000	4.12702

H	M	S	½ Elapsed Time.	Middle Time.	Rising.	H	M	S	½ Elapsed Time.	Middle Time.	Rising.
2	00	20	0.29994	5.00109	4.12938	2	12	20	0.26292	5.03811	4.20984
2	00	30	0.29939	5.00164	4.13055	2	12	30	0.26244	5.03859	4.21091
2	00	40	0.29885	5.00218	4.13172	2	12	40	0.26195	5.03908	4.21197
2	01	00	0.29776	5.00327	4.13406	2	13	00	0.26099	5.04004	4.21409
2	1	20	0.29668	5.00435	4.13640	2	13	20	0.26003	5.04100	4.21620
2	1	30	0.29614	5.00489	4.13756	2	13	30	0.25955	5.04148	4.21725
2	1	40	0.29560	5.00543	4.13872	2	13	40	0.25907	5.04196	4.21831
2	2	00	0.29453	5.00650	4.14104	2	14	00	0.25811	5.04292	4.22041
2	2	20	0.29346	5.00757	4.14336	2	14	20	0.25716	5.04387	4.22250
2	2	30	0.29293	5.00810	4.14451	2	14	30	0.25668	5.04435	4.22355
2	2	40	0.29239	5.00864	4.14566	2	14	40	0.25621	5.04482	4.22459
2	3	00	0.29133	5.00970	4.14797	2	15	00	0.25526	5.04577	4.22668
2	3	20	0.29027	5.01076	4.15026	2	15	20	0.25432	5.04671	4.22876
2	3	30	0.28974	5.01129	4.15140	2	15	30	0.25385	5.04718	4.22980
2	3	40	0.28921	5.01182	4.15255	2	15	40	0.25338	5.04765	4.23083
2	4	00	0.28816	5.01287	4.15483	2	16	00	0.25244	5.04859	4.23290
2	4	20	0.28711	5.01392	4.15710	2	16	20	0.25150	5.04953	4.23495
2	4	30	0.28659	5.01444	4.15824	2	16	30	0.25104	5.04999	4.23599
2	4	40	0.28607	5.01496	4.15937	2	16	40	0.25057	5.05046	4.23702
2	5	00	0.28502	5.01601	4.16163	2	17	00	0.24964	5.05139	4.23907
2	5	20	0.28398	5.01705	4.16389	2	17	20	0.24872	5.05231	4.24112
2	5	30	0.28346	5.01757	4.16501	2	17	30	0.24825	5.05278	4.24214
2	5	40	0.28295	5.01808	4.16614	2	17	40	0.24779	5.05324	4.24316
2	6	00	0.28191	5.01912	4.16838	2	18	00	0.24687	5.05416	4.24520
2	6	20	0.28089	5.02014	4.17062	2	18	20	0.24595	5.05508	4.24723
2	6	30	0.28037	5.02066	4.17173	2	18	30	0.24550	5.05553	4.24825
2	6	40	0.27986	5.02117	4.17285	2	18	40	0.24504	5.05599	4.24926
2	7	00	0.27884	5.02219	4.17507	2	19	00	0.24413	5.05690	4.25128
2	7	20	0.27782	5.02321	4.17729	2	19	20	0.24322	5.05781	4.25330
2	7	30	0.27731	5.02372	4.17839	2	19	30	0.24276	5.05827	4.25430
2	7	40	0.27680	5.02423	4.17950	2	19	40	0.24231	5.05872	4.25531
2	8	00	0.27579	5.02524	4.18171	2	20	00	0.24141	5.05962	4.25731
2	8	20	0.27478	5.02625	4.18391	2	20	20	0.24051	5.06052	4.25931
2	8	30	0.27428	5.02675	4.18500	2	20	30	0.24006	5.06097	4.26031
2	8	40	0.27378	5.02725	4.18610	2	20	40	0.23961	5.06142	4.26131
2	9	00	0.27277	5.02826	4.18828	2	21	00	0.23871	5.06232	4.26330
2	9	20	0.27177	5.02926	4.19047	2	21	20	0.23782	5.06321	4.26429
2	9	30	0.27127	5.02976	4.19156	2	21	30	0.23738	5.06365	4.26628
2	9	40	0.27077	5.03026	4.19265	2	21	40	0.23693	5.06410	4.26727
2	10	00	0.26978	5.03125	4.19482	2	22	00	0.23605	5.06498	4.26926
2	10	20	0.26879	5.03224	4.19698	2	22	20	0.23516	5.06587	4.27121
2	10	30	0.26830	5.03275	4.19806	2	22	30	0.23472	5.06631	4.27220
2	10	40	0.26781	5.03322	4.19914	2	22	40	0.23428	5.06675	4.27318
2	11	00	0.26682	5.03421	4.20129	2	23	00	0.23340	5.06763	4.27514
2	11	20	0.26584	5.03519	4.20344	2	23	20	0.23252	5.06851	4.27710
2	11	30	0.26535	5.03568	4.20451	2	23	30	0.23209	5.06894	4.27807
2	11	40	0.26486	5.03617	4.20558	2	23	40	0.23165	5.06938	4.27905
2	12	00	0.26389	5.03714	4.20771	2	24	00	0.23078	5.07025	4.28097

H	M	S	½ Elapsed Time.	Middle Time.	Rising.	H	M	S	½ Elapsed Time.	Middle Time.	Rising
2	24	20	0.22991	5.07112	4.28294	2	36	20	0.20035	5.10068	4.34980
2	24	30	0.22948	5.07155	4.28391	2	36	30	0.19996	5.10107	4.35069
2	24	40	0.22905	5.07198	4.28487	2	36	40	0.19957	5.10146	4.35158
2	25	00	0.22819	5.07284	4.28681	2	37	00	0.19880	5.10223	4.35335
2	25	20	0.22732	5.07371	4.28873	2	37	20	0.19803	5.10300	4.35512
2	25	30	0.22690	5.07413	4.28969	2	37	30	0.19764	5.10339	4.35601
2	25	40	0.22647	5.07456	4.29065	2	37	40	0.19726	5.10377	4.35689
2	26	00	0.22561	5.07512	4.29257	2	38	00	0.19649	5.10454	4.35865
2	26	20	0.22476	5.07627	4.29449	2	38	20	0.19572	5.10531	4.36041
2	26	30	0.22433	5.07670	4.29544	2	38	30	0.19534	5.10569	4.36128
2	26	40	0.22391	5.07712	4.29639	2	38	40	0.19496	5.10607	4.36216
2	27	00	0.22306	5.07797	4.29830	2	39	00	0.19420	5.10683	4.36391
2	27	20	0.22222	5.07881	4.30020	2	39	20	0.19344	5.10759	4.36565
2	27	30	0.22180	5.07923	4.30115	2	39	30	0.19306	5.10797	4.36653
2	27	40	0.22138	5.07965	4.30209	2	39	40	0.19269	5.10834	4.36740
2	28	00	0.22054	5.08049	4.30398	2	40	00	0.19193	5.10910	4.36913
2	28	20	0.21970	5.08133	4.30587	2	40	20	0.19118	5.10985	4.37087
2	28	30	0.21928	5.08175	4.30681	2	40	30	0.19081	5.11022	4.37173
2	28	40	0.21887	5.08216	4.30775	2	40	40	0.19043	5.11060	4.37260
2	29	00	0.21803	5.08300	4.30963	2	41	00	0.18968	5.11135	4.37432
2	29	20	0.21720	5.08383	4.31150	2	41	20	0.18894	5.11209	4.37604
2	29	30	0.21679	5.08424	4.31243	2	41	30	0.18857	5.11246	4.37690
2	29	40	0.21638	5.08465	4.31337	2	41	40	0.18820	5.11283	4.37776
2	30	00	0.21555	5.08548	4.31523	2	42	00	0.18746	5.11357	4.37948
2	30	20	0.21473	5.08630	4.31709	2	42	20	0.18672	5.11431	4.38119
2	30	30	0.21432	5.08671	4.31801	2	42	30	0.18635	5.11468	4.38204
2	30	40	0.21391	5.08712	4.31894	2	42	40	0.18598	5.11505	4.38289
2	31	00	0.21309	5.08794	4.32079	2	43	00	0.18525	5.11578	4.38459
2	31	20	0.21228	5.08875	4.32264	2	43	20	0.18451	5.11652	4.38629
2	31	30	0.21187	5.08916	4.32356	2	43	30	0.18415	5.11688	4.38714
2	31	40	0.21147	5.08956	4.32448	2	43	40	0.18378	5.11725	4.38799
2	32	00	0.21066	5.09037	4.32631	2	44	00	0.18306	5.11797	4.38968
2	32	20	0.20985	5.09118	4.32815	2	44	20	0.18233	5.11870	4.39137
2	32	30	0.20945	5.09158	4.32906	2	44	30	0.18197	5.11906	4.39221
2	32	40	0.20905	5.09198	4.32997	2	44	40	0.18161	5.11942	4.39305
2	33	00	0.20824	5.09279	4.33180	2	45	00	0.18089	5.12014	4.39473
2	33	20	0.20744	5.09359	4.33362	2	45	20	0.18017	5.12086	4.39641
2	33	30	0.20704	5.09399	4.33453	2	45	30	0.17981	5.12122	4.39725
2	33	40	0.20665	5.09438	4.33543	2	45	40	0.17945	5.12158	4.39808
2	34	00	0.20585	5.09518	4.33724	2	46	00	0.17874	5.12229	4.39975
2	34	20	0.20506	5.09597	4.33905	2	46	20	0.17802	5.12301	4.30142
2	34	30	0.20466	5.09637	4.33995	2	46	30	0.17767	5.12336	4.30225
2	34	40	0.20427	5.09676	4.34085	2	46	40	0.17731	5.12372	4.40308
2	35	00	0.20348	5.09755	4.34265	2	47	00	0.17660	5.12443	4.40474
2	35	20	0.20269	5.09834	4.34444	2	47	20	0.17590	5.12513	4.40639
2	35	30	0.20230	5.09873	4.34534	2	47	30	0.17554	5.12549	4.40722
2	35	40	0.20191	5.09912	4.34623	2	47	40	0.17519	5.12584	4.40804
2	36	00	0.20113	5.09990	4.34802	2	48	00	0.17449	5.12654	4.40969

H	M	S	½ Elapsed Time.	Middle Time.	Rifing.	H	M	S	½ Elapsed Time.	Middle Time.	Rifing.
2	48	20	0.17379	5.12724	4.41133	3	00	20	0.14988	5.15115	4.46823
2	48	30	0.17344	5.12759	4.41215	3	00	30	0.14957	5.15146	4.46899
2	48	40	0.17309	5.12794	4.41297	3	00	40	0.14926	5.15177	4.46975
2	49	00	0.17239	5.12864	4.41461	3	01	00	0.14863	5.15240	4.47127
2	49	20	0.17170	5.12933	4.41624	3	1	20	0.14800	5.15303	4.47278
2	49	30	0.17135	5.12968	4.41706	3	1	30	0.14769	5.15334	4.47354
2	49	40	0.17101	5.13002	4.41787	3	1	40	0.14738	5.15365	4.47430
2	50	00	0.17032	5.13071	4.41950	3	2	00	0.14676	5.15427	4.47580
2	50	20	0.16963	5.13140	4.42112	3	2	20	0.14614	5.15489	4.47731
2	50	30	0.16928	5.13175	4.42193	3	2	30	0.14583	5.15520	4.47806
2	50	40	0.16894	5.13209	4.42274	3	2	40	0.14552	5.15551	4.47881
2	51	00	0.16826	5.13277	4.42435	3	3	00	0.14490	5.15613	4.48031
2	51	20	0.16758	5.13345	4.42597	3	3	20	0.14429	5.15674	4.48180
2	51	30	0.16724	5.13379	4.42677	3	3	30	0.14398	5.15705	4.48255
2	51	40	0.16690	5.13413	4.42758	3	3	40	0.14368	5.15735	4.48330
2	52	00	0.16622	5.13481	4.42918	3	4	00	0.14307	5.15796	4.48479
2	52	20	0.16554	5.13549	4.43078	3	4	20	0.14246	5.15857	4.48627
2	52	30	0.16520	5.13583	4.43158	3	4	30	0.14215	5.15888	4.48701
2	52	40	0.16487	5.13616	4.43238	3	4	40	0.14185	5.15918	4.48776
2	53	00	0.16419	5.13684	4.43398	3	5	00	0.14124	5.15979	4.48924
2	53	20	0.16352	5.13751	4.43557	3	5	20	0.14064	5.16039	4.49071
2	53	30	0.16319	5.13784	4.43636	3	5	30	0.14034	5.16069	4.49145
2	53	40	0.16285	5.13818	4.43716	3	5	40	0.14004	5.16099	4.49219
2	54	00	0.16219	5.13884	4.43874	3	6	00	0.13944	5.16159	4.49365
2	54	20	0.16152	5.13951	4.44032	3	6	20	0.13884	5.16219	4.49513
2	54	30	0.16119	5.13984	4.44111	3	6	30	0.13854	5.16249	4.49586
2	54	40	0.16086	5.14017	4.44190	3	6	40	0.13824	5.16279	4.49659
2	55	00	0.16020	5.14083	4.44348	3	7	00	0.13765	5.16338	4.49806
2	55	20	0.15954	5.14149	4.44505	3	7	20	0.13705	5.16398	4.49952
2	55	30	0.15921	5.14182	4.44583	3	7	30	0.13676	5.16427	4.40024
2	55	40	0.15888	5.14215	4.44662	3	7	40	0.13646	5.16457	4.50098
2	56	00	0.15823	5.14280	4.44818	3	8	00	0.13587	5.16516	4.50243
2	56	20	0.15758	5.14345	4.44974	3	8	20	0.13528	5.16575	4.50388
2	56	30	0.15725	5.14378	4.45052	3	8	30	0.13499	5.16604	4.50461
2	56	40	0.15692	5.14411	4.45130	3	8	40	0.13470	5.16633	4.50533
2	57	00	0.15628	5.14475	4.45286	3	9	00	0.13411	5.16692	4.50677
2	57	20	0.15563	5.14540	4.45441	3	9	20	0.13353	5.16750	4.50822
2	57	30	0.15530	5.14573	4.45518	3	9	30	0.13324	5.16779	4.50894
2	57	40	0.15498	5.14605	4.45596	3	9	40	0.13295	5.16808	4.50966
2	58	00	0.15434	5.14669	4.45750	3	10	00	0.13237	5.16866	4.51109
2	58	20	0.15370	5.14733	4.45904	3	10	20	0.13179	5.16924	4.51253
2	58	30	0.15338	5.14765	4.45981	3	10	30	0.13150	5.16953	4.51325
2	58	40	0.15306	5.14797	4.46058	3	10	40	0.13121	5.16982	4.51396
2	59	00	0.15242	5.14861	4.46212	3	11	00	0.13064	5.17039	4.51539
2	59	20	0.15178	5.14925	4.46365	3	11	20	0.13007	5.17096	4.51681
2	59	30	0.15146	5.14957	4.46442	3	11	30	0.12978	5.17125	4.51753
2	59	40	0.15115	5.14988	4.46518	3	11	40	0.12950	5.17153	4.51824
3	00	00	0.15051	5.15052	4.46671	3	12	00	0.12893	5.17210	4.51966

H	M	S	½ Elapsed Time.	Middle Time.	Rising.	H	M	S	½ Elapsed Time.	Middle Time.	Rising
3	12	20	0.12836	5.17267	4.52107	3	24	20	0.10899	5.19204	4.57032
3	12	30	0.12807	5.17296	4.52178	3	24	30	0.10873	5.19230	4.57098
3	12	40	0.12779	5.17324	4.52249	3	24	40	0.10848	5.19255	4.57164
3	13	00	0.12723	5.17380	4.52390	3	25	00	0.10797	5.19306	4.57296
3	13	20	0.12666	5.17437	4.52531	3	25	20	0.10746	5.19357	4.57428
3	13	30	0.12638	5.17465	4.52601	3	25	30	0.10721	5.19382	4.57494
3	13	40	0.12610	5.17493	4.52672	3	25	40	0.10696	5.19407	4.57559
3	14	00	0.12554	5.17549	4.52812	3	26	00	0.10646	5.19457	4.57690
3	14	20	0.12499	5.17604	4.52952	3	26	20	0.10595	5.19508	4.57821
3	14	30	0.12471	5.17632	4.53022	3	26	30	0.10570	5.19533	4.57886
3	14	40	0.12443	5.17660	4.53092	3	26	40	0.10545	5.19558	4.57951
3	15	00	0.12387	5.17716	4.53231	3	27	00	0.10495	5.19603	4.58082
3	15	20	0.12332	5.17771	4.53371	3	27	20	0.10446	5.19657	4.58212
3	15	30	0.12305	5.17798	4.53440	3	27	30	0.10421	5.19682	4.58277
3	15	40	0.12277	5.17826	4.43510	3	27	40	0.10396	5.19707	4.58342
3	16	00	0.12222	5.17881	4.53648	3	28	00	0.10347	5.19756	4.58471
3	16	20	0.12167	5.17936	4.53787	3	28	20	0.10297	5.19806	4.58601
3	16	30	0.12140	5.17963	4.53856	3	28	30	0.10272	5.19831	4.58665
3	16	40	0.12113	5.17990	4.53925	3	28	40	0.10248	5.19855	4.58730
3	17	00	0.12058	5.18045	4.54063	3	29	00	0.10199	5.19904	4.58859
3	17	20	0.12004	5.18099	4.54201	3	29	20	0.10151	5.19952	4.58988
3	17	30	0.11977	5.18126	4.54269	3	29	30	0.10126	5.19977	4.59052
3	17	40	0.11949	5.18154	4.54338	3	29	40	0.10102	5.20001	4.59116
3	18	00	0.11895	5.18208	4.54475	3	30	00	0.10053	5.20050	4.59244
3	18	20	0.11842	5.18261	4.54612	3	30	20	0.10005	5.20098	4.59372
3	18	30	0.11815	5.18288	4.54680	3	30	30	0.09981	5.20122	4.59436
3	18	40	0.11788	5.18315	4.54749	3	30	40	0.09957	5.20146	4.59500
3	19	00	0.11734	5.18369	4.54885	3	31	00	0.09909	5.20194	4.59627
3	19	20	0.11681	5.18422	4.55021	3	31	20	0.09861	5.20242	4.59755
3	19	30	0.11654	5.18449	4.55089	3	31	30	0.09837	5.20266	4.59818
3	19	40	0.11628	5.18475	4.55157	3	31	40	0.09813	5.20290	4.59882
3	20	00	0.11575	5.18528	4.55293	3	32	00	0.09765	5.20338	4.60008
3	20	20	0.11522	5.18581	4.55428	3	32	20	0.09718	5.20385	4.60135
3	20	30	0.11495	5.18608	4.55496	3	32	30	0.09694	5.20409	4.60198
3	20	40	0.11469	5.18634	4.55563	3	32	40	0.09670	5.20433	4.60261
3	21	00	0.11416	5.18687	4.55698	3	33	00	0.09623	5.20480	4.60387
3	21	20	0.11364	5.18739	4.55832	3	33	20	0.09576	5.20527	4.60513
3	21	30	0.11338	5.18765	4.55900	3	33	30	0.09552	5.20551	4.60576
3	21	40	0.11312	5.18791	4.55967	3	33	40	0.09529	5.20574	4.60639
3	22	00	0.11259	5.18844	4.56101	3	34	00	0.09482	5.20621	4.60764
3	22	20	0.11207	5.18896	4.56235	3	34	20	0.09435	5.20668	4.60890
3	22	30	0.11181	5.18922	4.56301	3	34	30	0.09412	5.20691	4.60952
3	22	40	0.11155	5.18948	4.56368	3	34	40	0.09389	5.20714	4.61015
3	23	00	0.11104	5.18999	4.56501	3	35	00	0.09343	5.20760	4.61139
3	23	20	0.11052	5.19051	4.56634	3	35	20	0.09296	5.20807	4.61264
3	23	30	0.11027	5.19076	4.56701	3	35	30	0.09273	5.20830	4.61326
3	23	40	0.11001	5.19102	4.56767	3	35	40	0.09250	5.20853	4.61388
3	24	00	0.10950	5.19153	4.56900	3	36	00	0.09204	5.20899	4.61512

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H	M	S	½ Elapsed Time.	Middle Time.	Rising.	H	M	S	½ Elapsed Time.	Middle Time.	Rising.
3	36	20	0.09158	5.20945	4.61636	3	48	20	0.07600	5.22503	4.65952
3	36	30	0.09136	5.20967	4.61698	3	48	30	0.07579	5.22524	4.66010
3	36	40	0.09113	5.20990	4.61760	3	48	40	0.07559	5.22544	4.66068
3	37	00	0.09067	5.21036	4.61883	3	49	00	0.07518	5.22585	4.66184
3	37	20	0.09022	5.21081	4.62006	3	49	20	0.07478	5.22625	4.66299
3	37	30	0.08999	5.21104	4.62068	3	49	30	0.07458	5.22645	4.66357
3	37	40	0.08976	5.21127	4.62129	3	49	40	0.07437	5.22666	4.66415
3	38	00	0.08931	5.21172	4.62252	3	50	00	0.07397	5.22706	4.66530
3	38	20	0.08886	5.21217	4.62375	3	50	20	0.07357	5.22746	4.66645
3	38	30	0.08864	5.21239	4.62436	3	50	30	0.07337	5.22766	4.66702
3	38	40	0.08842	5.21261	4.62497	3	50	40	0.07317	5.22786	4.66760
3	39	00	0.08797	5.21306	4.62619	3	51	00	0.07277	5.22826	4.66874
3	39	20	0.08752	5.21351	4.62741	3	51	20	0.07237	5.22860	4.66989
3	39	30	0.08730	5.21373	4.62802	3	51	30	0.07217	5.22886	4.67046
3	39	40	0.08708	5.21395	4.62863	3	51	40	0.07197	5.22906	4.67103
3	40	00	0.08664	5.21439	4.62984	3	52	00	0.07158	5.22945	4.67217
3	40	20	0.08619	5.21484	4.63105	3	52	20	0.07119	5.22984	4.67331
3	40	30	0.08597	5.21506	4.63166	3	52	30	0.07099	5.23004	4.67388
3	40	40	0.08575	5.21528	4.63226	3	52	40	0.07079	5.23024	4.67445
3	41	00	0.08531	5.21572	4.63347	3	53	00	0.07040	5.23063	4.67558
3	41	20	0.08488	5.21615	4.63468	3	53	20	0.07001	5.23102	4.67671
3	41	30	0.08466	5.21637	4.63528	3	53	30	0.06982	5.23121	4.67728
3	41	40	0.08444	5.21659	4.63588	3	53	40	0.06962	5.23141	4.67785
3	42	00	0.08401	5.21702	4.63708	3	54	00	0.06923	5.23180	4.67897
3	42	20	0.08357	5.21746	4.63828	3	54	20	0.06885	5.23218	4.68010
3	42	30	0.08336	5.21767	4.63888	3	54	30	0.06865	5.23238	4.68066
3	42	40	0.08314	5.21789	4.63948	3	54	40	0.06846	5.23257	4.68123
3	43	00	0.08271	5.21832	4.64068	3	55	00	0.06808	5.23295	4.68235
3	43	20	0.08228	5.21875	4.64187	3	55	20	0.06770	5.23333	4.68347
3	43	30	0.08207	5.21896	4.64246	3	55	30	0.06751	5.23352	4.68403
3	43	40	0.08185	5.21918	4.64306	3	55	40	0.06731	5.23372	4.68459
3	44	00	0.08143	5.21960	4.64425	3	56	00	0.06693	5.23410	4.68517
3	44	20	0.08100	5.22003	4.64544	3	56	20	0.06656	5.23447	4.68682
3	44	30	0.08079	5.22024	4.64603	3	56	30	0.06637	5.23466	4.68738
3	44	40	0.08058	5.22045	4.64662	3	56	40	0.06618	5.23485	4.68794
3	45	00	0.08015	5.22088	4.64780	3	57	00	0.06580	5.23523	4.68905
3	45	20	0.07973	5.22130	4.64898	3	57	20	0.06543	5.23560	4.69016
3	45	30	0.07952	5.22151	4.64957	3	57	30	0.06524	5.23579	4.69071
3	45	40	0.07931	5.22172	4.65016	3	57	40	0.06505	5.23598	4.69127
3	46	00	0.07889	5.22214	4.65134	3	58	00	0.06468	5.23635	4.69237
3	46	20	0.07848	5.22255	4.65251	3	58	20	0.06431	5.23672	4.69348
3	46	30	0.07827	5.22276	4.65310	3	58	30	0.06412	5.23691	4.69403
3	46	40	0.07806	5.22297	4.65369	3	58	40	0.06394	5.23709	4.69458
3	47	00	0.07765	5.22338	4.65486	3	59	00	0.06357	5.23746	4.69568
3	47	20	0.07723	5.22380	4.65602	3	59	20	0.06320	5.23783	4.69678
3	47	30	0.07703	5.22400	4.65661	3	59	30	0.06302	5.23801	4.69733
3	47	40	0.07682	5.22421	4.65719	3	59	40	0.06283	5.23820	4.69787
3	48	00	0.07641	5.22462	4.65836	4	00	00	0.06247	5.23856	4.69897

H	M	S	½ Elapsed Time.	Middle Time.	Rising.	H	M	S	½ Elapsed Time.	Middle Time.	Rising
4	0	20	0.06211	5.23892	4.70006	4	12	20	0.04980	5.25123	4.73823
4	0	30	0.06192	5.23911	4.70061	4	12	30	0.04964	5.25139	4.73874
4	0	40	0.06174	5.23929	4.70115	4	12	40	0.04948	5.25155	4.73926
4	1	00	0.06138	5.23965	4.70224	4	13	00	0.04916	5.25187	4.74028
4	1	20	0.06102	5.24001	4.70333	4	13	20	0.04884	5.25219	4.74131
4	1	30	0.06084	5.24019	4.70387	4	13	30	0.04868	5.25235	4.74182
4	1	40	0.06066	5.24037	4.70442	4	13	40	0.04852	5.25251	4.74233
4	2	00	0.06030	5.24073	4.70550	4	14	00	0.04821	5.25282	4.74335
4	2	20	0.05995	5.24108	4.70658	4	14	20	0.04789	5.25314	4.74437
4	2	30	0.05977	5.24126	4.70712	4	14	30	0.04774	5.25329	4.74488
4	2	40	0.05959	5.24144	4.70766	4	14	40	0.04758	5.25345	4.74539
4	3	00	0.05924	5.24179	4.70874	4	15	00	0.04727	5.25376	4.74641
4	3	20	0.05888	5.24215	4.70928	4	15	20	0.04696	5.25407	4.74742
4	3	30	0.05871	5.24232	4.71036	4	15	30	0.04680	5.25423	4.74793
4	3	40	0.05853	5.24250	4.71089	4	15	40	0.04665	5.25438	4.74844
4	4	00	0.05818	5.24285	4.71197	4	16	00	0.04634	5.25469	4.74945
4	4	20	0.05783	5.24320	4.71304	4	16	20	0.04603	5.25500	4.75046
4	4	30	0.05766	5.24337	4.71357	4	16	30	0.04588	5.25515	4.75096
4	4	40	0.05748	5.24355	4.71411	4	16	40	0.04573	5.25530	4.75147
4	5	00	0.05714	5.24389	4.71518	4	17	00	0.04542	5.25561	4.75247
4	5	20	0.05679	5.24424	4.71624	4	17	20	0.04512	5.25591	4.75348
4	5	30	0.05662	5.24441	4.71678	4	17	30	0.04496	5.25607	4.75398
4	5	40	0.05645	5.24458	4.71731	4	17	40	0.04481	5.25622	4.75448
4	6	00	0.05610	5.24493	4.71837	4	18	00	0.04451	5.25652	4.75549
4	6	20	0.05576	5.24527	4.71943	4	18	20	0.04421	5.25682	4.75649
4	6	30	0.05559	5.24544	4.71996	4	18	30	0.04406	5.25697	4.75699
4	6	40	0.05542	5.24561	4.72049	4	18	40	0.04391	5.25712	4.75748
4	7	00	0.05508	5.24595	4.72155	4	19	00	0.04361	5.25742	4.75848
4	7	20	0.05474	5.24629	4.72260	4	19	20	0.04332	5.25771	4.75948
4	7	30	0.05457	5.24646	4.72313	4	19	30	0.04317	5.25786	4.75997
4	7	40	0.05440	5.24663	4.72366	4	19	40	0.04302	5.25801	4.76047
4	8	00	0.05406	5.24697	4.72471	4	20	00	0.04272	5.25831	4.76146
4	8	20	0.05373	5.24730	4.72576	4	20	20	0.04243	5.25860	4.76245
4	8	30	0.05356	5.24747	4.72628	4	20	30	0.04228	5.25875	4.76295
4	8	40	0.05340	5.24763	4.72681	4	20	40	0.04214	5.25889	4.76344
4	9	00	0.05306	5.24797	4.72735	4	21	00	0.04185	5.25918	4.76443
4	9	20	0.05273	5.24830	4.72890	4	21	20	0.04155	5.25948	4.76542
4	9	30	0.05257	5.24846	4.72942	4	21	30	0.04141	5.25962	4.76591
4	9	40	0.05240	5.24863	4.72994	4	21	40	0.04127	5.25976	4.76640
4	10	00	0.05207	5.24896	4.73098	4	22	00	0.04098	5.26005	4.76738
4	10	20	0.05174	5.24929	4.73202	4	22	20	0.04069	5.26034	4.76836
4	10	30	0.05158	5.24945	4.73254	4	22	30	0.04055	5.26048	4.76885
4	10	40	0.05142	5.24961	4.73306	4	22	40	0.04040	5.26063	4.76934
4	11	00	0.05109	5.24994	4.73410	4	23	00	0.04012	5.26091	4.77032
4	11	20	0.05076	5.25027	4.73514	4	23	20	0.03983	5.26120	4.77130
4	11	30	0.05060	5.25043	4.73565	4	23	30	0.03969	5.26134	4.77179
4	11	40	0.05044	5.25059	4.73617	4	23	40	0.03955	5.26148	4.77227
4	12	00	0.05012	5.25091	4.73720	4	24	00	0.03927	5.26176	4.77325

H	M	S	½ Elapsed Time.	Middle Time.	Rising.	H	M	S	½ Elapsed Time.	Middle Time.	Rising.
4	24	20	0.03899	5.26204	4.77422	4	36	20	0.02961	5.27142	4.80820
4	24	30	0.03885	5.26218	4.77470	4	36	30	0.02949	5.27154	4.80866
4	24	40	0.03871	5.26232	4.77519	4	36	40	0.02937	5.27166	4.80912
4	25	00	0.03843	5.26260	4.77616	4	37	00	0.02913	5.27190	4.81004
4	25	20	0.03815	5.26288	4.77713	4	37	20	0.02889	5.27214	4.81095
4	25	30	0.03802	5.26301	4.77761	4	37	30	0.02877	5.27226	4.81141
4	25	40	0.03788	5.26315	4.77809	4	37	40	0.02865	5.27238	4.81186
4	26	00	0.03760	5.26343	4.77906	4	38	00	0.02841	5.27262	4.81277
4	26	20	0.03733	5.26370	4.78002	4	38	20	0.02818	5.27285	4.81368
4	26	30	0.03719	5.26384	4.78050	4	38	30	0.02806	5.27297	4.81414
4	26	40	0.03706	5.26397	4.78098	4	38	40	0.02794	5.27309	4.81459
4	27	00	0.03678	5.26425	4.78194	4	39	00	0.02771	5.27332	4.81550
4	27	20	0.03651	5.26452	4.78290	4	39	20	0.02748	5.27355	4.81641
4	27	30	0.03638	5.26465	4.78338	4	39	30	0.02736	5.27367	4.81686
4	27	40	0.03624	5.26479	4.78385	4	39	40	0.02724	5.27379	4.81731
4	28	00	0.03597	5.26506	4.78481	4	40	00	0.02701	5.27402	4.81821
4	28	20	0.03571	5.26532	4.78576	4	40	20	0.02678	5.27425	4.81911
4	28	30	0.03557	5.26546	4.78624	4	40	30	0.02667	5.27436	4.81956
4	28	40	0.03544	5.26559	4.78671	4	40	40	0.02656	5.27447	4.82001
4	29	00	0.03517	5.26586	4.78767	4	41	00	0.02633	5.27470	4.82091
4	29	20	0.03491	5.26612	4.78861	4	41	20	0.02610	5.27493	4.82181
4	29	30	0.03478	5.26625	4.78908	4	41	30	0.02599	5.27504	4.82226
4	29	40	0.03465	5.26638	4.78956	4	41	40	0.02588	5.27515	4.82271
4	40	00	0.03438	5.26665	4.79051	4	42	00	0.02565	5.27538	4.82360
4	30	20	0.03412	5.26691	4.79145	4	42	20	0.02543	5.27560	4.82449
4	30	30	0.03399	5.26704	4.79192	4	42	30	0.02532	5.27571	4.82494
4	30	40	0.03386	5.26717	4.79240	4	42	40	0.02521	5.27582	4.82538
4	31	00	0.03360	5.26743	4.79334	4	43	00	0.02499	5.27604	4.82628
4	31	20	0.03335	5.26768	4.79428	4	43	20	0.02477	5.27626	4.82716
4	31	30	0.03322	5.26781	4.79475	4	43	30	0.02466	5.27637	4.82761
4	31	40	0.03309	5.26794	4.79522	4	43	40	0.02455	5.27648	4.82805
4	32	00	0.03283	5.26820	4.79615	4	44	00	0.02433	5.27670	4.82894
4	32	20	0.03258	5.26845	4.79709	4	44	20	0.02411	5.27692	4.82982
4	32	30	0.03245	5.26858	4.79756	4	44	30	0.02400	5.27703	4.83026
4	32	40	0.03233	5.26870	4.79802	4	44	40	0.02390	5.27713	4.83071
4	33	00	0.03207	5.26896	4.79896	4	45	00	0.02368	5.27735	4.83159
4	33	20	0.03182	5.26921	4.79989	4	45	20	0.02347	5.27756	4.83247
4	33	30	0.03170	5.26933	4.80035	4	45	30	0.02336	5.27767	4.83291
4	33	40	0.03157	5.26946	4.80082	4	45	40	0.02326	5.27777	4.83335
4	34	00	0.03132	5.26971	4.80175	4	46	00	0.02304	5.27799	4.83423
4	34	20	0.03107	5.26996	4.80267	4	46	20	0.02283	5.27800	4.83510
4	34	30	0.03095	5.27008	4.80314	4	46	30	0.02273	5.27830	4.83554
4	34	40	0.03083	5.27020	4.80360	4	46	40	0.02262	5.27841	4.83598
4	35	00	0.03058	5.27045	4.80452	4	47	00	0.02241	5.27862	4.83685
4	35	20	0.03034	5.27069	4.80544	4	47	20	0.02221	5.27882	4.83773
4	35	30	0.03021	5.27082	4.80591	4	47	30	0.02210	5.27893	4.83816
4	35	40	0.03009	5.27094	4.80637	4	47	40	0.02200	5.27903	4.83860
4	36	00	0.02984	5.27118	4.80729	4	48	00	0.02179	5.27924	4.83947

H	M	S	½ Elapsed Time.	Middle Time.	Rising.	H	M	S	½ Elapsed Time.	Middle Time.	Rising.
4	48	20	0.02159	5.27944	4.84034	5	0	20	0.01489	5.28614	4.87075
4	48	30	0.02149	5.27954	4.84077	5	0	30	0.01480	5.28623	4.87116
4	48	40	0.02139	5.27964	4.84120	5	0	40	0.01472	5.28631	4.87157
4	49	00	0.02128	5.27985	4.84207	5	1	00	0.01455	5.28648	4.87239
4	49	20	0.02098	5.28005	4.84293	5	1	20	0.01439	5.28664	4.87321
4	49	30	0.02088	5.28015	4.84337	5	1	30	0.01430	5.28673	4.87362
4	49	40	0.02078	5.28025	4.84380	5	1	40	0.01422	5.28681	4.87402
4	50	00	0.02058	5.28045	4.84466	5	2	00	0.01406	5.28697	4.87484
4	50	20	0.02038	5.28065	4.84552	5	2	20	0.01390	5.28713	4.87566
4	50	30	0.02028	5.28075	4.84595	5	2	30	0.01381	5.28722	4.87606
4	50	40	0.02018	5.28085	4.84638	5	2	40	0.01373	5.28730	4.87647
4	51	00	0.01999	5.28104	4.84724	5	3	00	0.01357	5.28746	4.87728
4	51	20	0.01979	5.28124	4.84810	5	3	20	0.01341	5.28762	4.87809
4	51	30	0.01969	5.28134	4.84852	5	3	30	0.01333	5.28770	4.87850
4	51	40	0.01960	5.28143	4.84895	5	3	40	0.01325	5.28778	4.87890
4	52	00	0.01940	5.28163	4.84981	5	4	00	0.01310	5.28793	4.87971
4	52	20	0.01921	5.28182	4.85066	5	4	20	0.01294	5.28809	4.88052
4	52	30	0.01912	5.28191	4.85108	5	4	30	0.01286	5.28817	4.88093
4	52	40	0.01902	5.28201	4.85151	5	4	40	0.01278	5.28825	4.88133
4	53	00	0.01883	5.28220	4.85236	5	5	00	0.01263	5.28840	4.88213
4	53	20	0.01864	5.28239	4.85321	5	5	20	0.01247	5.28856	4.88294
4	53	30	0.01854	5.28249	4.85363	5	5	30	0.01240	5.28863	4.88334
4	53	40	0.01845	5.28258	4.85406	5	5	40	0.01232	5.28871	4.88374
4	54	00	0.01826	5.28277	4.85490	5	6	00	0.01217	5.28886	4.88454
4	54	20	0.01808	5.28295	4.85575	5	6	20	0.01202	5.28901	4.88534
4	54	30	0.01798	5.28305	4.85617	5	6	30	0.01194	5.28909	4.88574
4	54	40	0.01789	5.28314	4.85659	5	6	40	0.01187	5.28916	4.88614
4	55	00	0.01771	5.28332	4.85744	5	7	00	0.01172	5.28931	4.88694
4	55	20	0.01752	5.28351	4.85828	5	7	20	0.01157	5.28946	4.88774
4	55	30	0.01743	5.28360	4.85870	5	7	30	0.01150	5.28953	4.88814
4	55	40	0.01734	5.28369	4.85912	5	7	40	0.01142	5.28961	4.88853
4	56	00	0.01716	5.28387	4.85996	5	8	00	0.01128	5.28975	4.88933
4	56	20	0.01698	5.28405	4.86079	5	8	20	0.01113	5.28990	4.89012
4	56	30	0.01689	5.28414	4.86121	5	8	30	0.01106	5.28997	4.89052
4	56	40	0.01680	5.28423	4.86163	5	8	40	0.01099	5.29004	4.89091
4	57	00	0.01662	5.28441	4.86246	5	9	00	0.01084	5.29019	4.89171
4	57	20	0.01644	5.28459	4.86330	5	9	20	0.01070	5.29033	4.89250
4	57	30	0.01635	5.28468	4.86372	5	9	30	0.01063	5.29040	4.89289
4	57	40	0.01626	5.28477	4.86413	5	9	40	0.01056	5.29047	4.89328
4	58	00	0.01609	5.28494	4.86496	5	10	00	0.01042	5.29061	4.89407
4	58	20	0.01591	5.28512	4.86579	5	10	20	0.01028	5.29075	4.89486
4	58	30	0.01583	5.28520	4.86621	5	10	30	0.01021	5.29082	4.89525
4	58	40	0.01574	5.28529	4.86662	5	10	40	0.01014	5.29089	4.89564
4	59	00	0.01557	5.28546	4.86745	5	11	00	0.01000	5.29102	4.89643
4	59	20	0.01540	5.28563	4.86828	5	11	20	0.00987	5.29116	4.89721
4	59	30	0.01531	5.28572	4.86869	5	11	30	0.00980	5.29123	4.89760
4	59	40	0.01523	5.28580	4.86910	5	11	40	0.00973	5.29130	4.89799
5	00	00	0.01506	5.28597	4.86992	5	12	00	0.00960	5.29143	4.89877

I

H	M	S	½ Elapsed Time.	Middle Time.	Rising.	H	M	S	½ Elapsed Time.	Middle Time.	Rising.
5	12	20	0.00946	5.28157	4.89955	5	24	20	0.00528	5.29575	4.92686
5	12	30	0.00940	5.28163	4.89994	5	24	30	0.00523	5.29580	4.92723
5	12	40	0.00933	5.28170	4.90033	5	24	40	0.00518	5.29585	4.92760
5	13	00	0.00920	5.28183	4.90111	5	25	00	0.00508	5.29595	4.92833
5	13	20	0.00907	5.29190	4.90188	5	25	20	0.00499	5.29604	4.92907
5	13	30	0.00900	5.29203	4.90227	5	25	30	0.00494	5.29609	4.92944
5	13	40	0.00894	5.29209	4.90266	5	25	40	0.00489	5.29614	4.92980
5	14	00	0.00881	5.29222	4.90345	5	26	00	0.00480	5.29623	4.93054
5	14	20	0.00868	5.29235	4.90421	5	26	20	0.00470	5.29633	4.93127
5	14	30	0.00862	5.29241	4.90459	5	26	30	0.00466	5.29637	4.93164
5	14	40	0.00855	5.29248	4.90498	5	26	40	0.00461	5.29642	4.93200
5	15	00	0.00843	5.29260	4.90575	5	27	00	0.00452	5.29651	4.93273
5	15	20	0.00830	5.29273	4.90652	5	27	20	0.00443	5.29660	4.93340
5	15	30	0.00824	5.29279	4.90690	5	27	30	0.00438	5.29665	4.93383
5	15	40	0.00818	5.29285	4.90728	5	27	40	0.00434	5.29669	4.93419
5	16	00	0.00805	5.29298	4.90805	5	28	00	0.00425	5.29678	4.93492
5	16	20	0.00793	5.29310	4.90882	5	28	20	0.00416	5.29687	4.93564
5	16	30	0.00787	5.29316	4.90920	5	28	30	0.00412	5.29691	4.93600
5	16	40	0.00781	5.29322	4.90958	5	28	40	0.00407	5.29696	4.93637
5	17	00	0.00769	5.29334	4.91034	5	29	00	0.00399	5.29704	4.93709
5	17	20	0.00757	5.29346	4.91111	5	29	20	0.00390	5.29713	4.93781
5	17	30	0.00751	5.29352	4.91149	5	29	30	0.00386	5.29717	4.93817
5	17	40	0.00745	5.29358	4.91187	5	29	40	0.00382	5.29721	4.93854
5	18	00	0.00733	5.29370	4.91263	5	30	00	0.00373	5.29730	4.93926
5	18	20	0.00722	5.29381	4.91339	5	30	20	0.00365	5.29738	4.93998
5	18	30	0.00716	5.29387	4.91377	5	30	30	0.00361	5.29742	4.94034
5	18	40	0.00710	5.29393	4.91415	5	30	40	0.00357	5.29746	4.94069
5	19	00	0.00699	5.29404	4.91490	5	31	00	0.00349	5.29754	4.94141
5	19	20	0.00687	5.29416	4.91566	5	31	20	0.00341	5.29762	4.94213
5	19	30	0.00682	5.29421	4.91603	5	31	30	0.00337	5.29766	4.94249
5	19	40	0.00676	5.29427	4.91641	5	31	40	0.00333	5.29770	4.94284
5	20	00	0.00665	5.29438	4.91716	5	32	00	0.00325	5.29778	4.94356
5	20	20	0.00654	5.29449	4.91792	5	32	20	0.00317	5.29786	4.94427
5	20	30	0.00648	5.29455	4.91830	5	32	30	0.00313	5.29790	4.94463
5	20	40	0.00643	5.29460	4.91867	5	32	40	0.00310	5.29793	4.94498
5	21	00	0.00632	5.29471	4.91942	5	33	00	0.00302	5.29801	4.94570
5	21	20	0.00621	5.29482	4.92017	5	33	20	0.00295	5.29808	4.94641
5	21	30	0.00616	5.29487	4.92054	5	33	30	0.00291	5.29812	4.94676
5	21	40	0.00610	5.29493	4.92092	5	33	40	0.00287	5.29816	4.94712
5	22	00	0.00600	5.29503	4.92166	5	34	00	0.00280	5.29823	4.94782
5	22	20	0.00589	5.29514	4.92241	5	34	20	0.00273	5.29830	4.94853
5	22	30	0.00584	5.29519	4.92278	5	34	30	0.00269	5.29834	4.94888
5	22	40	0.00579	5.29524	4.92315	5	34	40	0.00266	5.29837	4.94924
5	23	00	0.00568	5.29535	4.92390	5	35	00	0.00259	5.29844	4.94994
5	23	20	0.00558	5.29545	4.92464	5	35	20	0.00252	5.29851	4.95065
5	23	30	0.00553	5.29550	4.92501	5	35	30	0.00249	5.29854	4.95100
5	23	40	0.00548	5.29555	4.92538	5	35	40	0.00245	5.29858	4.95135
5	24	00	0.00538	5.29565	4.92612	5	36	00	0.00239	5.29864	4.95205

H	M	S	½ Elapsed Time.	Middle Time.	Rising.	H	M	S	½ Elapsed Time.	Middle Time.	Rising.
5	36	20	0.00232	5.29871	4.95275	5	48	20	0.00056	5.30047	4.97732
5	36	30	0.00229	5.29874	4.95310	5	48	30	0.00055	5.30048	4.97765
5	36	40	0.00225	5.29878	4.95345	5	48	40	0.00053	5.30050	4.97798
5	37	00	0.00219	5.29884	4.95415	5	49	00	0.00050	5.30053	4.97865
5	37	20	0.00213	5.29890	4.95485	5	49	20	0.00047	5.30056	4.97931
5	37	30	0.00210	5.29893	4.95520	5	49	30	0.00046	5.30057	4.97964
5	37	40	0.00207	5.29896	4.95555	5	49	40	0.00044	5.30059	4.97997
5	38	00	0.00200	5.29903	4.95624	5	50	00	0.00041	5.30062	4.98063
5	38	20	0.00194	5.29909	4.95694	5	50	20	0.00039	5.30064	4.98129
5	38	30	0.00191	5.29912	4.95728	5	50	30	0.00037	5.30066	4.98162
5	38	40	0.00188	5.29915	4.95763	5	50	40	0.00036	5.30067	4.98195
5	39	00	0.00183	5.29920	4.95832	5	51	00	0.00033	5.30070	4.98261
5	39	20	0.00177	5.29926	4.95902	5	51	20	0.00031	5.30072	4.98326
5	39	30	0.00174	5.29929	4.95936	5	51	30	0.00030	5.30073	4.98359
5	39	40	0.00171	5.29932	4.95971	5	51	40	0.00029	5.30074	4.98392
5	40	00	0.00166	5.29937	4.96040	5	52	00	0.00026	5.30077	4.98457
5	40	20	0.00160	5.29943	4.96109	5	52	20	0.00024	5.30079	4.98523
5	40	30	0.00157	5.29946	4.96143	5	52	30	0.00023	5.30080	4.98555
5	40	40	0.00155	5.29948	4.96177	5	52	40	0.02022	5.30081	4.98588
5	41	00	0.00149	5.29954	4.96246	5	53	00	0.00020	5.30083	4.98653
5	41	20	0.00144	5.29959	4.96315	5	53	20	0.00018	5.30085	4.98718
5	41	30	0.00142	5.29961	4.96349	5	53	30	0.00017	5.30086	4.98751
5	41	40	0.00139	5.29964	4.96383	5	53	40	0.00017	5.30086	4.98783
5	42	00	0.00134	5.29969	4.96451	5	54	00	0.00015	5.30088	4.98848
5	42	20	0.00129	5.29974	4.96520	5	54	20	0.00013	5.30090	4.98913
5	42	30	0.00127	5.29976	4.96554	5	54	30	0.00013	5.30090	4.98945
5	42	40	0.00124	5.29979	4.96588	5	54	40	0.00012	5.30091	4.98978
5	43	00	0.00120	5.29983	4.96656	5	55	00	0.00010	5.30093	4.99042
5	43	20	0.00115	5.29988	4.96724	5	55	20	0.00009	5.30094	4.99107
5	43	30	0.00113	5.29990	4.96758	5	55	30	0.00008	5.30095	4.99139
5	43	40	0.00110	5.29993	4.96792	5	55	40	0.00008	5.30095	4.99171
5	44	00	0.00106	5.29997	4.96860	5	56	00	0.00007	5.30096	4.99235
5	44	20	0.00102	5.30001	4.96927	5	56	20	0.00006	5.30097	4.99300
5	44	30	0.00099	5.30004	4.96961	5	56	30	0.00005	5.30098	4.99332
5	44	40	0.00097	5.30006	4.96995	5	56	40	0.00005	5.30098	4.99364
5	45	00	0.00093	5.30010	4.97062	5	57	00	0.00004	5.30099	4.99428
5	45	20	0.00089	5.30014	4.97130	5	57	20	0.00003	5.30100	4.99492
5	45	30	0.00087	5.30016	4.97163	5	57	30	0.00003	5.30100	4.99524
5	45	40	0.00085	5.30018	4.97197	5	57	40	0.00002	5.30101	4.99556
5	46	00	0.00081	5.30022	4.97264	5	58	00	0.00002	5.30101	4.99619
5	46	20	0.00077	5.30026	4.97331	5	58	20	0.00001	5.30102	4.99683
5	46	30	0.00075	5.30028	4.97365	5	58	30	0.00001	5.30102	4.99715
5	46	40	0.00074	5.30029	4.97398	5	58	40	0.00001	5.30102	4.99747
5	47	00	0.00070	5.30033	4.97465	5	59	00	0.00000	5.30102	4.99810
5	47	20	0.00066	5.30037	4.97532	5	59	20	0.00000	5.30103	4.99873
5	47	30	0.00065	5.30038	4.97565	5	59	30	0.00000	5.30103	4.99905
5	47	40	0.00063	5.30040	4.97599	5	59	40	0.00000	5.30103	4.99937
5	48	00	0.00060	5.30043	4.97665	6	00	00	0.00000	5.30103	5.00000
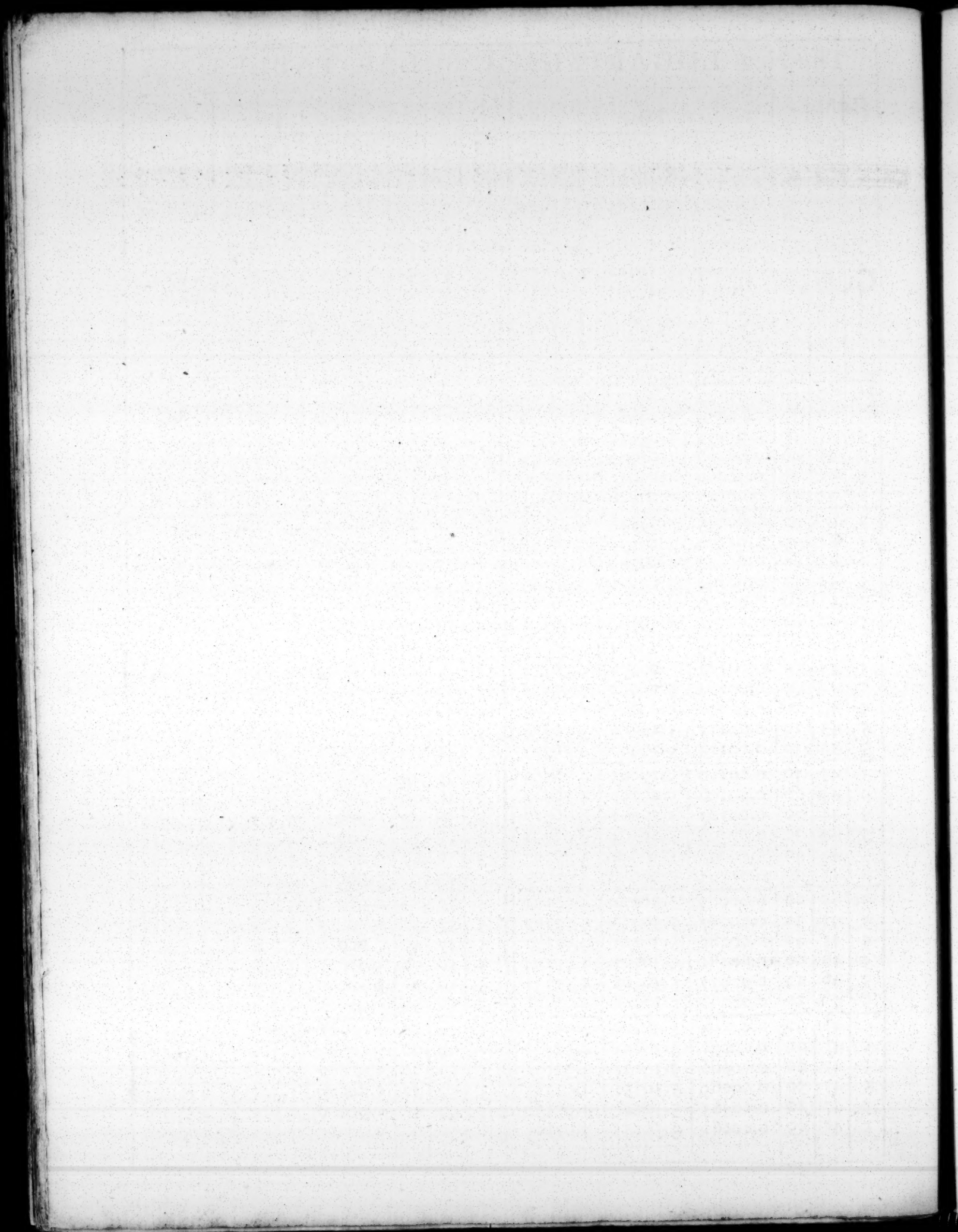
# General CONSTRUCTION of the foregoing LOGARITHMIC TABLES.

IN Order to facilitate the Method of calculating the Numbers in these Tables, it may be necessary to premise the two subsequent Lemmas:

LEMMA I.

The Rectangle of the Sines (to the Radius 1) of any two Sides of a spherical Triangle, drawn into the Co-sine of the Angle they include, being added to the Rectangle of their Co-sines, will be equal to the Co-sine of the third Side.

DEMONSTRATION.

Let H Z O N represent the Plane of a Section of a Sphere passing through its Center A, upon which imagine two great Circles thereof, as Z ⊙ N, P ⊙ S, orthographically projected, ⊙ their Point of Intersection; draw the Diameters Z N, P S, and at right Angles to the latter draw Q A E, to which draw F ⊙ D parallel: This done, let O A H be drawn perpendicular to Z N, and let fall the Perpendiculars P G, P S, D B, D T, V ⊙ M, I L, and ⊙ K; then in the spherical Triangle Z P ⊙, A W will represent the Co-sine (Radius being A E) of the Angle Z P ⊙, D I the Sine of ⊙ P (D P) A I its Co-sine, P S the Sine of Z P, A S its Co-sine. Now A E : A W :: D I ⊙ I (by the Property of the Ellipse) also by similar Triangles A E : P G ::
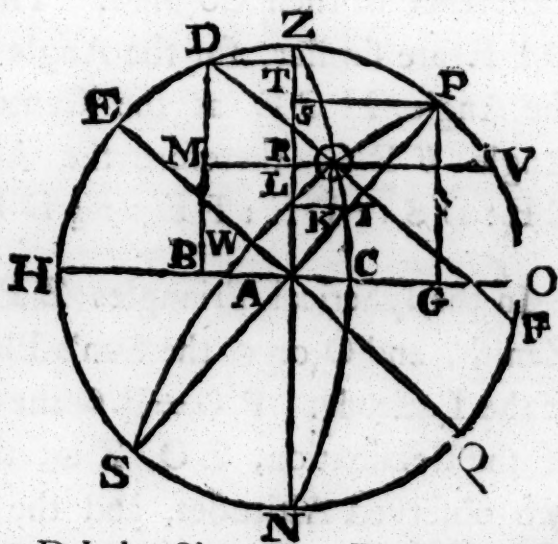
K   A I

$AI : AL$ and $AE : AG :: \odot I : \odot K = RL$ therefore $AR = AL$

$+ RL = \dfrac{AI \times PG}{AE} + \dfrac{DI \times AW}{AE} \times \dfrac{AG}{AE}$; which (making $AE = 1$)

becomes $AI \times PG + DI \times AW \times AG$. Q.E.D.

LEMMA II.

As Radius is to the Sine of half the Sum of any two Arches or Angles, fo is the Sine of half their Difference to half the Difference of the Co fines of the fame two Arches.

DEMONSTRATION.

Let DH and HI be two given Arches; make $HE = HI$, then will ED be the Difference of thofe Arches, draw the Radii CD, CE, CH and CI, alfo the Chords IE, ED and DI, let fall CS and DG Perpendiculars to ID and CH refpectively; laftly, draw EF parallel to CH, then will DS be the Sine of half the Sum of the propofed Arches, DE twice the Sine of half their Difference, and $EF (= GL)$ the Difference of their Co-fines. The Triangles, CDS, DFE are fimilar, for the Angle IDE at the Circumference is equal to the Angle HCE at the Center, equal, becaufe of Parallels, to the Angle FEC, therefore the Angle $CDS =$ Angle DEF; whence $CE : DS :: DE : FE :: \frac{1}{2}DE : \frac{1}{2}EF$. Q.E.D.
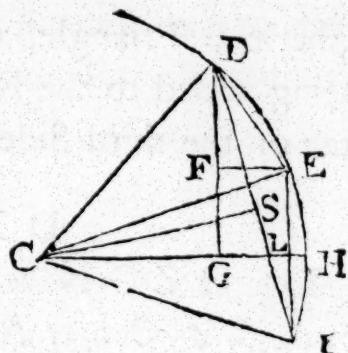
In the fpherical Triangles ZPO, $ZP\odot$, let P be the Pole, Z the Zenith, and O or $\odot$ the Sun's Place; then will PZ be the Complement of the Latitude. $PO = P\odot$ the the Sun's Polar Diftance or Complement of the Declination, ZO, $Z\odot$, the Complement of two obferved Altitudes, and the Angle $OP\odot$ the Difference of Time between thofe Obfervations.
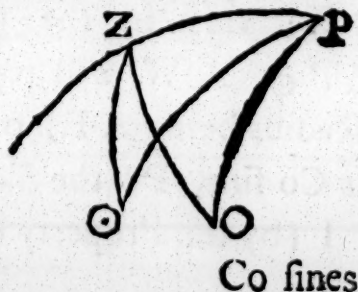
Put m for the Rectangle of the natural Sines (Radius 1) of ZP and $P\odot$, n for that of their

Co fines

Co-sines, a and b for the Sines of the observed Altitude, or the Co-sines of Z O, and Z ⊙ respectively; x for the Co-sine of the Angle Z P ⊙, y for the Co-sine of Z P O, and for the Sine of half the Angle O P ⊙, put s. Then by Lemma I. $mx + n = b$, and $my + n = a$, hence, by Subtraction, $m \times \overline{x - y} = b - a$. By Lemma II. we have 1. : Sine $\frac{1}{2}$ Z P ⊙ $+ \frac{1}{2}$ Z P O : : Sine of $\frac{1}{2}$ ⊙ P O : $\frac{1}{2}$ the Difference of the Co-sines of the Angles Z P ⊙, Z P O; that is 1 : Sine $\frac{1}{2}$ Z P ⊙ $+ \frac{1}{2}$ Z P O : : s : $\frac{x - y}{2}$

but from the Equation above we have $\frac{x - y}{2} = \frac{b - a}{2m}$, hence, by Substitution $\frac{b - a}{2ms} =$ Sine $\frac{1}{2}$ Z P ⊙ $+ \frac{1}{2}$ Z P O, or the Sine of Z P ⊙ $+ \frac{1}{2}$ ⊙ P O,

which in Words at length, gives this general Rule. Take the natural Sine of the observed Altitudes, and subtract the less from the greater, noting their Difference. Then take the natural Co-sines of the Latitude and Declination, and twice the natural Sine of half the Difference of Time, (converted into Degrees and Minutes; between the Observations; multiply these three Quantities together, by which Product divide the reserved Difference, and the Quotient will give the natural Sine of an Angle, (which must be reduced to equatorial Time) corresponding to the mean, or middle-Time, so called in the Tables, because it is half the Sum of the two Hour Angles from Noon.

In order to shew the Practice of this Rule, let the first Example at page 12, be again proposed, where there is given the Sun's Declination, 11° 17′ North, and at 10h. 2m. in the Forenoon the Sun's Altitude was 46d. 55m. then again at 11h. 27m. the second Altitude was 54° 7′. Latitude by Account is 46° 50′ North, required the true Latitude, and true Time of the Day, when the greatest Altitude was taken?

SOLUTION.

The natural Sine of Alt. 54° 7' ——————————————— .810212
The natural Sine of Alt. 46° 55' ——————————————— .730361

Difference .079851

The natural Co-fine of Lat. 46° 50' —————————————— .684122
The natural Co-fine of Declination 11° 17' ———————— .980672

The Time of Obfervation, 11h. 27m. and 10h. 2m. their Difference 1h. 25m. its half 0h. 42m. 30f. to which anfwers 10° 37½ twice the natural Sine thereof is .36876, therefore multiply .68412, .98067 and .36876, together, their Product becomes .2474, by which dividing the referved Difference .079851, the quotient .32276 is the natural Sine of 18° 49½, which converted into Time, allowing 15° to an Hour, as ufual, gives 1h. 15m. and 18f. very near, for the mean or middle Time required. From which fubftract 42m. 30f. half the elapfed Time, and there will remain 32m. 48f. the true Time from Noon, when the greateft Altitude was taken.

From a due Confideration of the above general Rule and its Example, it will not be difficult to point out the Method of conftructing thefe Tables; for expounding the faid Rule in Logarithms, we have Log.

$$b - a + \text{Log} \frac{1}{m} + \text{Log. } \tfrac{1}{2} + \text{Log. } \frac{1}{s} = \text{Log. Sine of } \textit{Middle Time, or}$$

putting R for the former Part, $R + \text{Log. } \frac{1}{s} = \text{Log. M. T.}$ Now, as

R remains conftantly the fame, it will, by applying this Theorum to the Conftruction of the Tables, evidently appear that the Columns marked *Half Elapfed Time,* contain the Arith. Comp. of the Sines of half the elapfed Time, equalled to Degrees and Minutes, thus againft two Hours we find 3.30103 the Arith. Comp. of the Log. of the Sine of 30°, and againft three Hours we have 0.15051, which is the Arith. Comp. of the Sine of 45°.

In this Manner the other Numbers in thofe Columns are determined.

By refuming the original Equation, viz. $\frac{b-a}{2\,m\,s}$ = Sine M T, we have Log. $b-a$ + Log. $\frac{1}{m}$ + Log. $\frac{1}{2\,s}$ = Log. Sine M T, and therefore as Log. $b-a$ + Log. $\frac{1}{m}$ may be confidered as unaffected by s, it follows that the Numbers in the Column marked *Middle Time*, are the refpective Logarithms of twice s, that is of twice the natural Sines of the Times in Degrees, which they ftand againft, or which is the fame Thing, the Logarithms of the Chords of double thofe Times reduced into Degrees, as before. Thus againft three Hours we find 5.15052, which is the Logarithm of twice the natural Sine of 45°, againft four Hours ftands 5.23856, the Logarithm of twice the natural Sine of 60°, and the like for any other.

It only now remains to fhew the Conftruction of the Numbers in the laft Column, marked *Rifing*, to do this take again the general Equation $\frac{b-a}{2\,m\,s}$ = the Sine of Z P ⊙ + ⊙ P O, which, when the Sun is upon the Meridian, will become $\frac{b-a}{2\,m\,s}$ = s, wherein b now reprefents the Sine of the Sun's Meridian Altitude) and confequently $\frac{b-a}{m}$ = 2 s^2, which fhews that the Numbers in the Column marked *Rifing*, are proportional to 2 s^2. And becaufe by the Property of the Circle, the Square of the Chord is equal to the Rectangle under the Diameter and verfed Sine, it follows that the Numbers in the faid Column are the Logarithmic verfed Sines of the Times reduced to Degrees, againft which they ftand ; Radius being Unity as before.

Note, In thefe Tables the Logarithmic Radix is fuppofed to be 100000 and confequently the greateft Index 5, which regnlates the inferior Indices, and likewife fhews that the natural Sines and verfed Sines, can at moft confift of but five Places of Figures : And moreover that the Sum of each correfponding Pair of Numbers in the Columns of *Half Elapfed* and *Middle Time* conftantly make 5.30103, anfwering to the Logarithm of 200000 the double Radix.

F I N I S.

$$56 - \quad 3474$$
$$30 \cdot 30 \quad 2506$$
$$\overline{11 \cdot 30 \quad 960}$$
$$\begin{array}{c} 60 \\ \overline{696} \end{array}$$

$$\begin{array}{c} 960 \\ 3000 \\ \overline{72 \cdot 7} \end{array}$$

$$\begin{array}{c} 56 \\ 6c \\ \overline{3000} \end{array}$$

$$\begin{array}{c} 2 \cdot 9830 \\ 3 \cdot 4771 \\ \overline{16 \cdot 4913} \end{array}$$

$$9 \cdot 4072$$

$$2 \cdot 8380$$

$$\begin{array}{c} 2247 \\ \overline{7492} \end{array} \quad 3 \cdot 3516$$

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Day		Date	Course				Lat	Long			Notes
...day	17	S14W	75	1.							
...nesday	18	S27W	93	81	42	26.57	53.17	0.47	2362		
...nsday	19	S63W	130	60	116	25.57	55.26	2.9	2388		
...day	20	N79W	119	32	114	25.25	57.32	2.6	2502		
...turday	21	S79W	114	21	112	25.4	59.38	2.6	2614	CT N69W 363 L.	
...day	22	S80W	148	4	148	25.0	62.21	2.43	2762		
...day	23	N86W	116	8	116	25.8	64.29	2.8	2878		
...day	24	N82W	47	6	42	25.14	65.15	0.46	2920		
...nesday	25	N86W	133	4	136	25.18	67.45	2.30	3056		
...rsday	26	N85W	145	12	144	25.30	70.24	2.39	3200	CT. N53.01W 210 L.	
...day	27	N19W	62	59	20	26.29	70.46	0.22	3220		
...unday	28	S7W	34	34	4	25.55	70.51	0.5	3224		
...day	29	N8oE	20	3	20	25.52	70.29	0.22	3202		
...unday	30	S72W	55	17	52	25.35	71.27	0.58	3254		
...day	1	N54W	19	11	15	25.46	71.43	0.16	3269		
...urday	2	S81W	19	3	19	25.43	72.4	0.21	3288		
...nd.?	3	N84W	36	-4	36	25.47	72.44	0.40	3324	ES. N46W 137 L.	
...day	4	N40W	45	30	33	26.17	73.21	0.37	3357		
...turday	5	N37W	115	92	69	27.49	74.39	1.18	3426	CT N51W 82 L.	
	6	N52W	156	96	123	29.25	76.57	2.10	3549	1at Po Obs. 31.18. Aat. O Red	
...day	7	Soundings	25fm			31.18	78.3.6			I45 · 30.33	

(margin) 63.40